

09/913778

Figure 1

Publication	PECVD Reaction	Doping Control Method	Post-dose Thermal Anneal Temp (°C)
Valette S., 1987	Unknown	P doping	Not specified
Valette S., 1988	Unknown	P doping	400°C
Grand G., 1990	Unknown	P doping	1000°C
Liu K., 1995	Unknown	Content in Si, P	Not specified
Ojha S., 1998	Unknown	Ge, B, or P doping	Not specified
Canning J., 1998	Unknown	Ge doping	Not specified
Bulla D., 1998	TEOS	TEOS	Not specified
Johnson C., 1998	$\text{SiH}_4 + \text{O}_2$	Si ion Implantation	400°C
Boswell R. W., 1997	$\text{SiH}_4 + \text{O}_2$	SiH_4/O_2 flow ratio	1000°C
Bazylenko M. V., 1995	$\text{SiH}_4 + \text{O}_2 + \text{CF}_4$	$(\text{SiH}_4 + \text{O}_2)/\text{CF}_4$ flow ratio	Not specified
Bazylenko M. V., 1996	$\text{SiH}_4 + \text{O}_2 + \text{CF}_4$	$(\text{SiH}_4 + \text{O}_2)/\text{CF}_4$ flow ratio	1000°C
Durand A., 1996	$\text{SiH}_4 + \text{O}_2 + \text{CF}_4$	$\text{SiH}_4/\text{O}_2/\text{CF}_4$ flow ratio	100°C
Kapser K., 1991	$\text{SiH}_4 + \text{N}_2\text{O}$	$\text{SiH}_4/\text{N}_2\text{O}$ flow ratio	1060°C
Lai Q., 1992	$\text{SiH}_4 + \text{N}_2\text{O}$	$\text{SiH}_4/\text{N}_2\text{O}$ flow ratio	1100°C
Lai Q., 1993	$\text{SiH}_4 + \text{N}_2\text{O}$	$\text{SiH}_4/\text{N}_2\text{O}$ flow ratio	1100°C
Pereyra I., 1997	$\text{SiH}_4 + \text{N}_2\text{O}$	$\text{SiH}_4/\text{N}_2\text{O}$ flow ratio	400°C
Alayo M., 1998	$\text{SiH}_4 + \text{N}_2\text{O}$	$\text{SiH}_4/\text{N}_2\text{O}$ flow ratio	1000°C
Kenyon T., 1997	$\text{SiH}_4 + \text{N}_2\text{O} + \text{Ar}$	$\text{SiH}_4/\text{N}_2\text{O}/\text{Ar}$ flow ratio	1000°C
Lam D. K. W., 1984	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3$	$\text{SiH}_4/\text{N}_2\text{O}/\text{NH}_3$ flow ratio	Not specified
Bruno F., 1991	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3$	$\text{SiH}_4/\text{N}_2\text{O}/\text{NH}_3$ flow ratio	1100°C
Yokohama S., 1995	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3$	$\text{SiH}_4/\text{N}_2\text{O}/\text{NH}_3$ flow ratio	Not specified
Agnihotri O. P., 1997	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3$	$\text{SiH}_4/\text{N}_2\text{O}/\text{NH}_3$ flow ratio	700-900°C
Germann R., 1999	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3$	Unknown	1100°C
Offrein B., 1999	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3$	Unknown	1150°C
Hoffmann M., 1995	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3 + \text{Ar}$	$\text{SiH}_4/\text{N}_2\text{O}/\text{NH}_3/\text{Ar}$ flow ratio	Not specified
Hoffmann M., 1997	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3 + \text{Ar}$	$\text{SiH}_4/\text{N}_2\text{O}/\text{NH}_3/\text{Ar}$ flow ratio	Not specified
Tu Y., 1995	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3 + \text{N}_2$	$\text{N}_2\text{O}/(\text{N}_2\text{O} + \text{NH}_3)$ flow ratio	1050°C
Poenar D., 1997	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3 + \text{N}_2$	$\text{SiH}_4/\text{N}_2\text{O}/\text{NH}_3/\text{N}_2$ flow ratio	850°C
Ridder R., 1998	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3 + \text{N}_2$	$\text{SiH}_4/\text{N}_2\text{O}/\text{NH}_3/\text{Ar}$ flow ratio	1100°C
Worhoff K., 1999	$\text{SiH}_4 + \text{N}_2\text{O} + \text{NH}_3 + \text{N}_2$	$\text{SiH}_4/\text{N}_2\text{O}/\text{NH}_3/\text{N}_2$ flow ratio	1150°C
Bulat E.S., 1993	$\text{SiH}_4 + \text{N}_2\text{O} + \text{N}_2 + \text{O}_2 + \text{He} + \text{CF}_4$	$\text{SiH}_4/(\text{N}_2\text{O}/\text{N}_2)/\text{O}_2/\text{CF}_4$ flow ratio	425°C
This Patent Application	$\text{SiH}_4 + \text{N}_2\text{O} + \text{PH}_3 + \text{N}_2$	Patented Pending Method	650°C

Figure 2

Figure 2 shows the FTIR spectra of the samples. The x-axis represents the wavenumber in cm⁻¹, ranging from 4000 to 400. The y-axis represents the transmittance. The spectra show characteristic peaks for the samples, including peaks around 3400 cm⁻¹ (O-H stretching), 2900 cm⁻¹ (C-H stretching), 1700 cm⁻¹ (C=O stretching), and various peaks in the fingerprint region (1500-400 cm⁻¹).

		HO-H	SiOH	SiN-H	SiN-H	Si-H	Si=O	N=N	Si-O-Si	Si-O-Si	Si-ON	Si-OH	Si-O-Si	Si-O-Si	
FTIR	1st mode (cm-1)	Min	3550	3470	3380	3300	2210	1800	1530	1080	1000	910	860	740	410
	Ave	3650	3510	3420	3380	2260	1875	1555	1180	1080	950	885	810	460	
	Max	3750	3550	3460	3460	2310	1950	1580	1280	1160	990	910	880	510	
1st mode (μm)	Min	2.817	2.882	2.959	3.030	4.525	5.556	6.536	9.259	10.000	10.989	11.628	13.514	24.390	
	Ave	2.740	2.849	2.924	2.959	4.425	5.333	6.431	8.475	9.259	10.526	11.299	12.346	21.739	
	Max	2.667	2.817	2.890	2.890	4.329	5.128	6.329	7.813	8.621	10.101	10.989	11.364	19.608	
2nd mode (μm)	Min	1.408	1.441	1.479	1.515	2.262	2.778	3.268	4.630	5.000	5.495	5.814	6.757	12.195	
	Ave	1.370	1.425	1.462	1.479	2.212	2.667	3.215	4.237	4.630	5.263	5.650	6.173	10.870	
	Max	1.333	1.408	1.445	1.445	2.165	2.564	3.165	3.906	4.310	5.051	5.495	5.682	9.804	
3rd mode (μm)	Min	0.939	0.961	0.986	1.010	1.508	1.852	2.179	3.086	3.333	3.663	3.876	4.505	8.130	
	Ave	0.913	0.950	0.975	0.986	1.475	1.778	2.144	2.825	3.086	3.509	3.766	4.115	7.246	
	Max	0.889	0.939	0.963	0.963	1.443	1.709	2.110	2.604	2.874	3.367	3.663	3.788	6.536	
4th mode (μm)	Min	0.704	0.720	0.740	0.758	1.131	1.389	1.634	2.315	2.500	2.747	2.907	3.378	6.098	
	Ave	0.685	0.712	0.731	0.740	1.106	1.333	1.608	2.119	2.315	2.632	2.825	3.086	5.435	
	Max	0.667	0.704	0.723	0.723	1.082	1.282	1.582	1.953	2.155	2.525	2.747	2.841	4.902	
5th mode (μm)	Min	0.563	0.576	0.592	0.606	0.905	1.111	1.307	1.852	2.000	2.198	2.326	2.703	4.878	
	Ave	0.548	0.570	0.585	0.592	0.885	1.067	1.286	1.695	1.852	2.105	2.260	2.469	4.348	
	Max	0.533	0.563	0.578	0.578	0.866	1.026	1.266	1.563	1.724	2.020	2.198	2.273	3.922	
6th mode (μm)	Min	0.469	0.480	0.493	0.505	0.754	0.926	1.089	1.543	1.667	1.832	1.938	2.252	4.065	
	Ave	0.457	0.475	0.487	0.493	0.737	0.889	1.072	1.412	1.543	1.754	1.883	2.058	3.623	
	Max	0.444	0.469	0.482	0.482	0.722	0.855	1.055	1.302	1.437	1.684	1.832	1.894	3.268	
7th mode (μm)	Min	0.402	0.412	0.423	0.433	0.646	0.794	0.934	1.323	1.429	1.570	1.661	1.931	3.484	
	Ave	0.391	0.407	0.418	0.423	0.632	0.762	0.919	1.211	1.323	1.504	1.614	1.764	3.106	
	Max	0.381	0.402	0.413	0.413	0.618	0.733	0.904	1.116	1.232	1.443	1.570	1.623	2.801	
8th mode (μm)	Min	0.352	0.360	0.370	0.379	0.566	0.694	0.817	1.157	1.250	1.374	1.453	1.689	3.049	
	Ave	0.342	0.356	0.365	0.370	0.553	0.667	0.804	1.059	1.157	1.316	1.412	1.543	2.717	
	Max	0.333	0.352	0.361	0.361	0.541	0.641	0.791	0.977	1.078	1.263	1.374	1.420	2.451	

Figure 3a

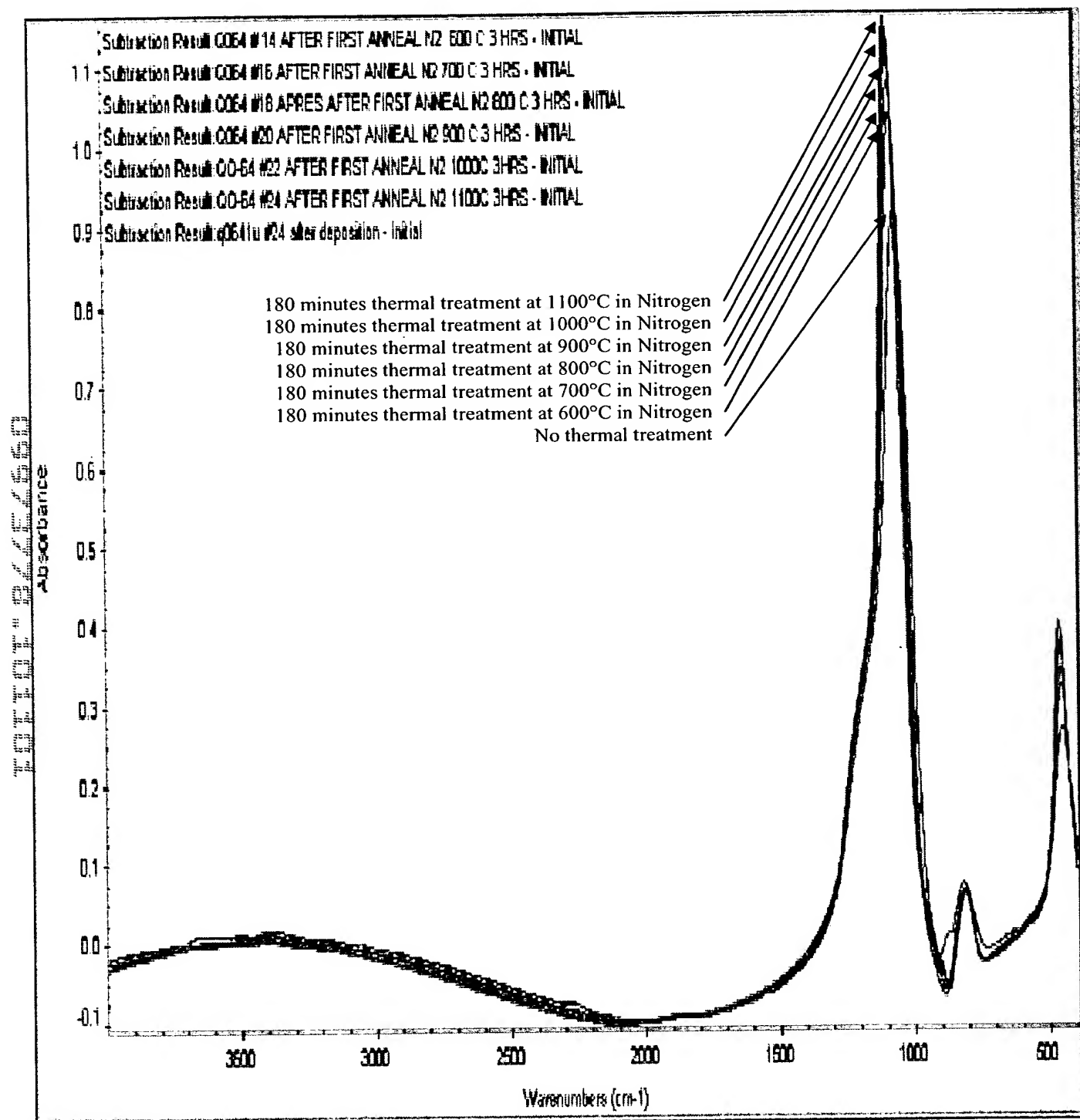


Figure 3b

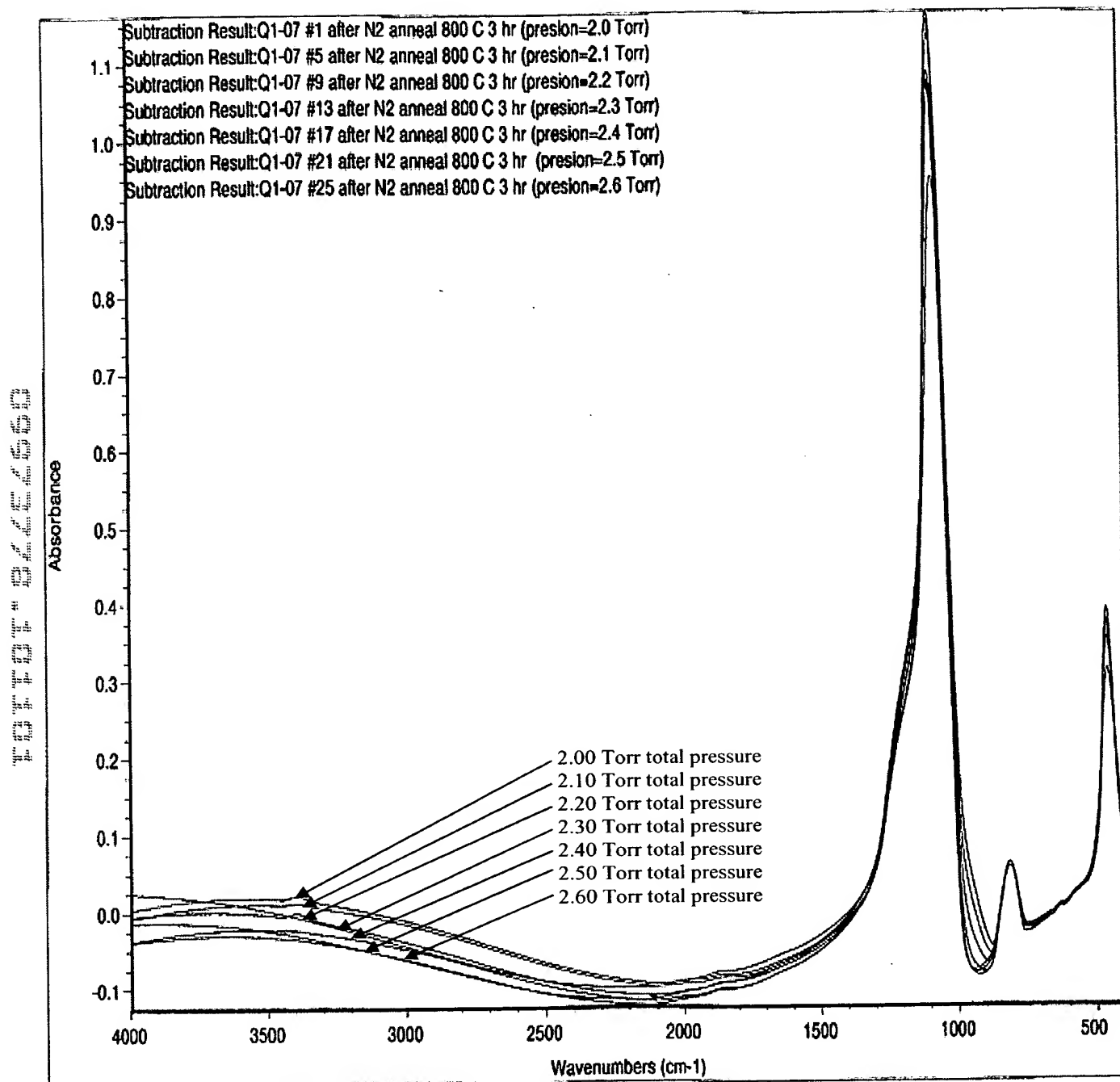


Figure 3c

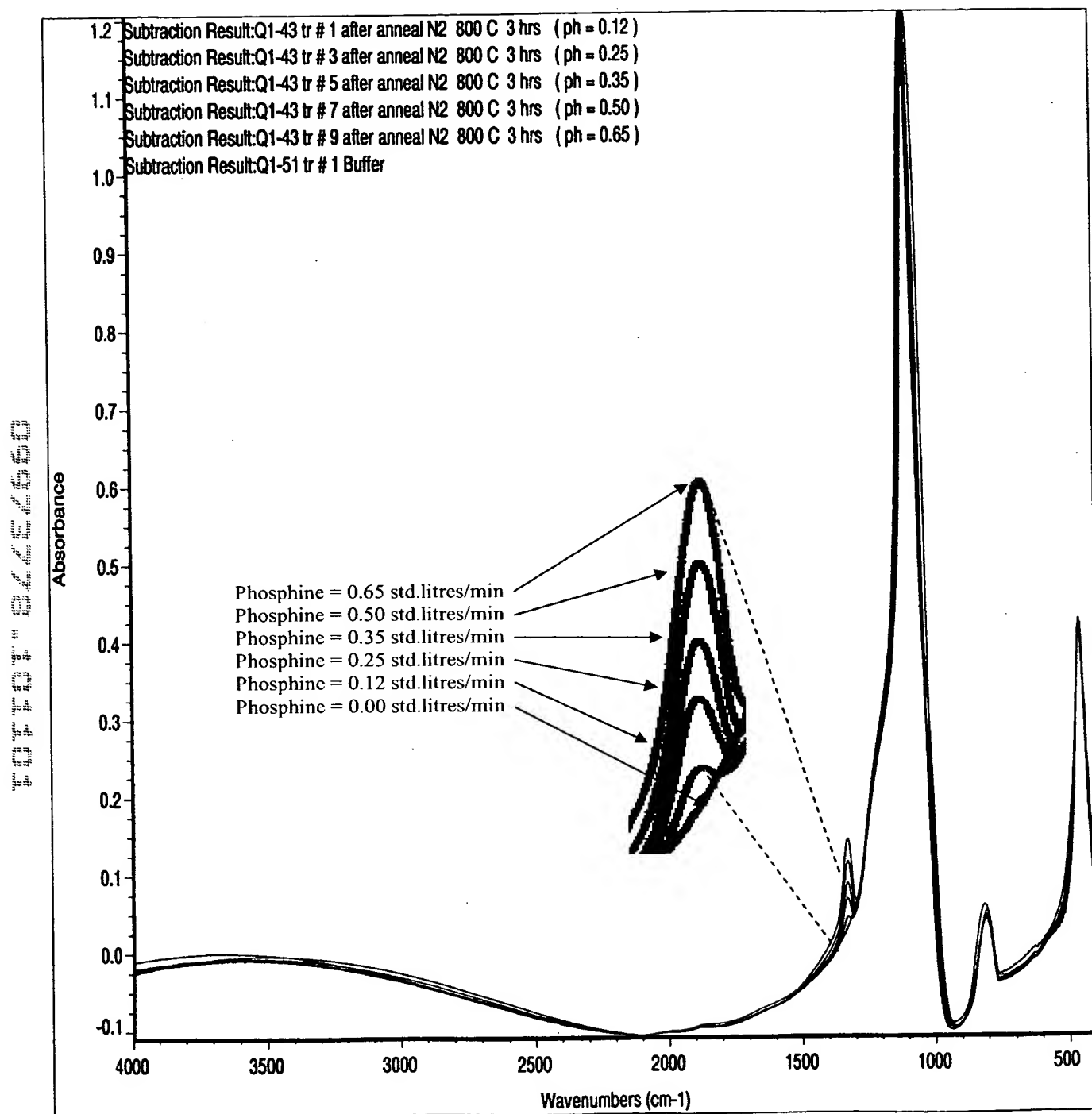


Figure 3d

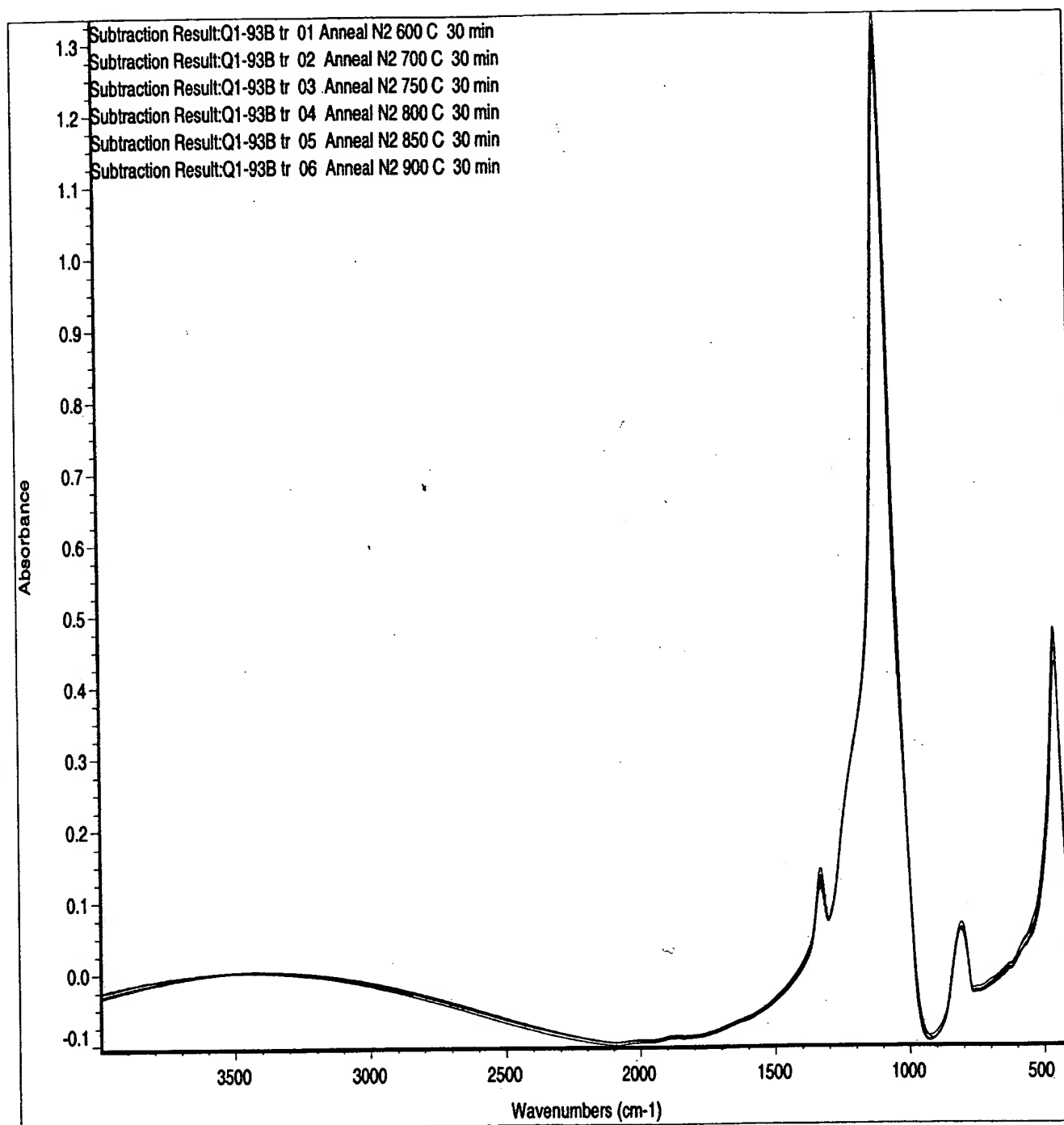


Figure 4a

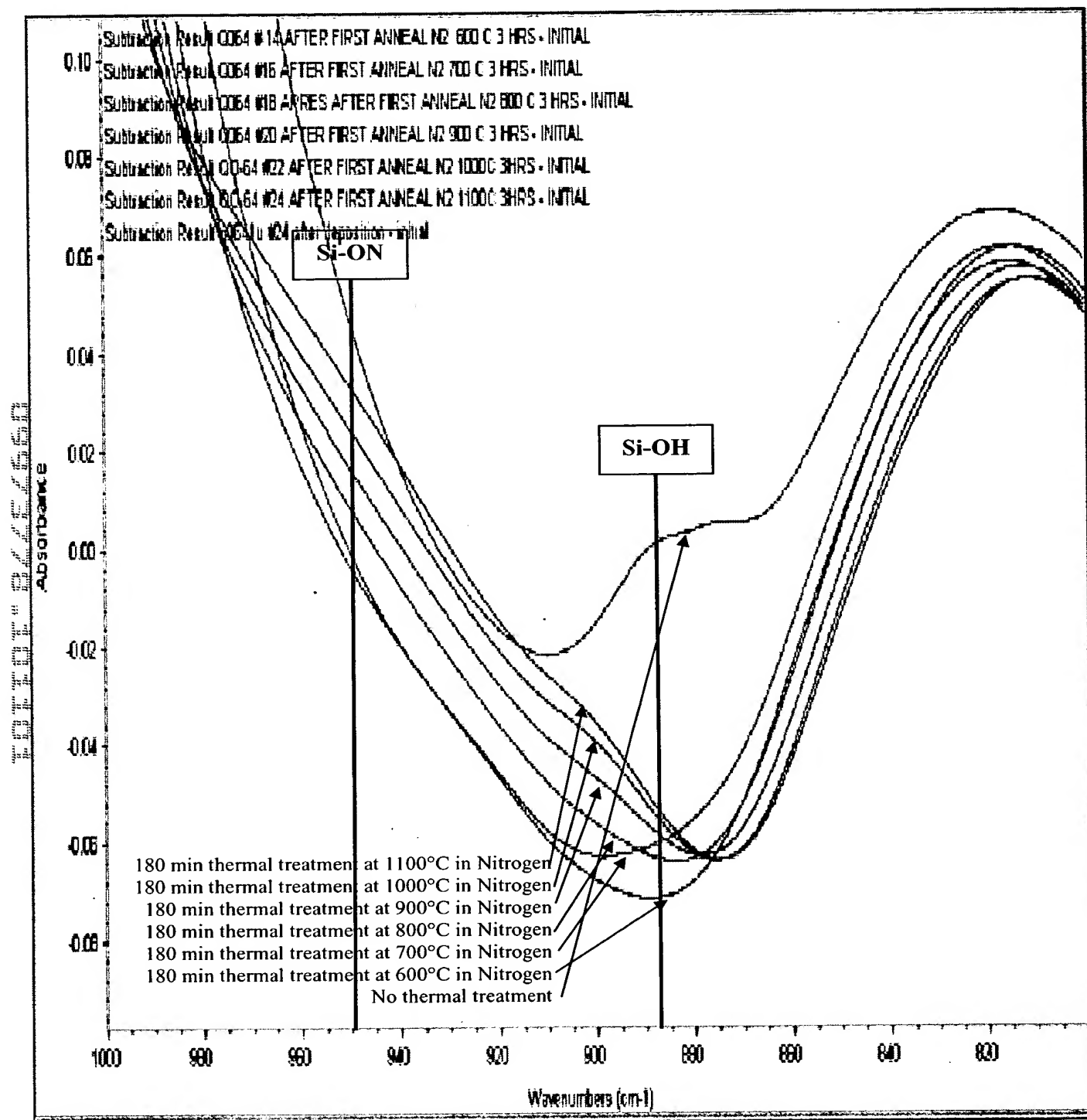


Figure 4b

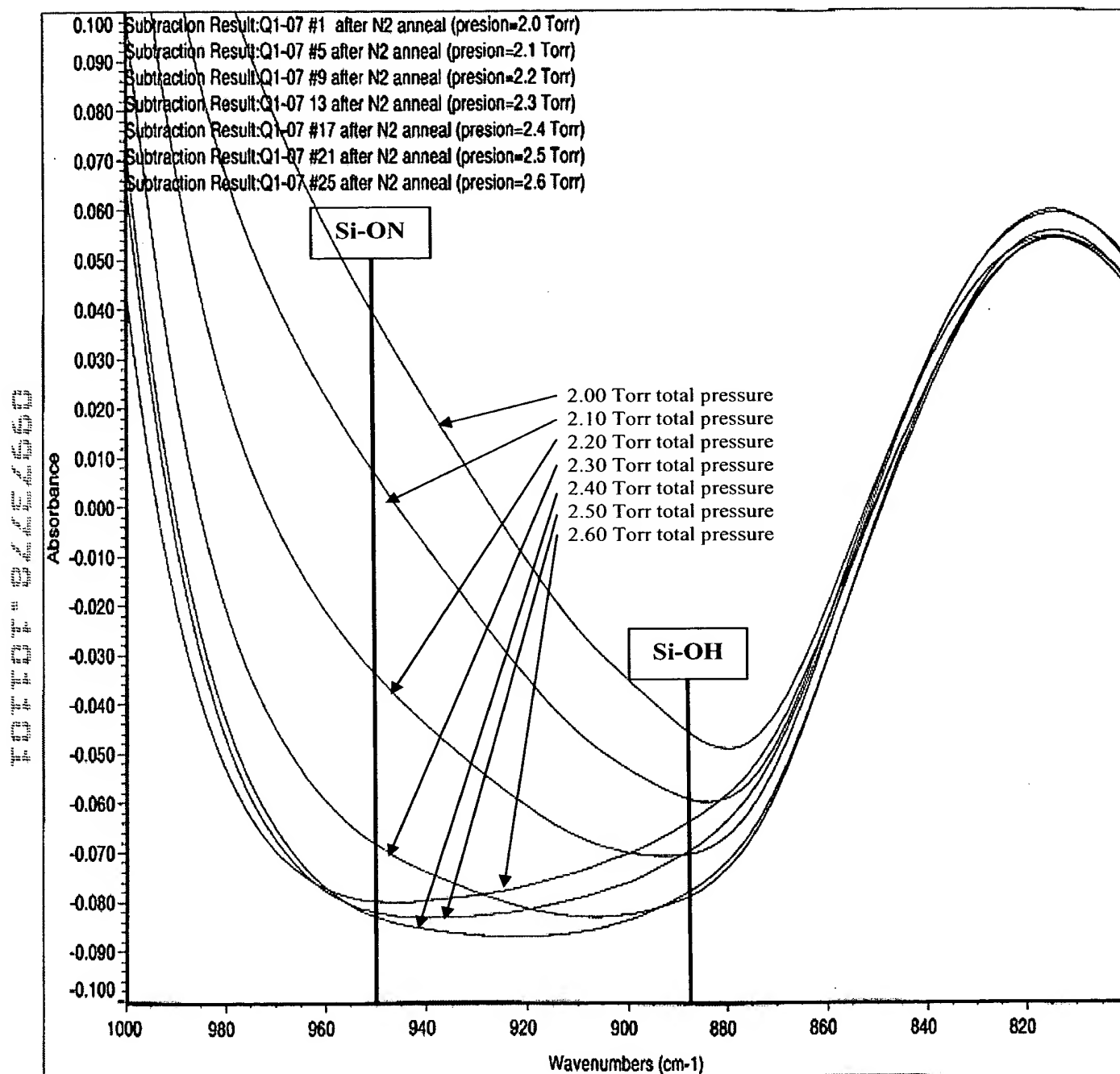


Figure 4c

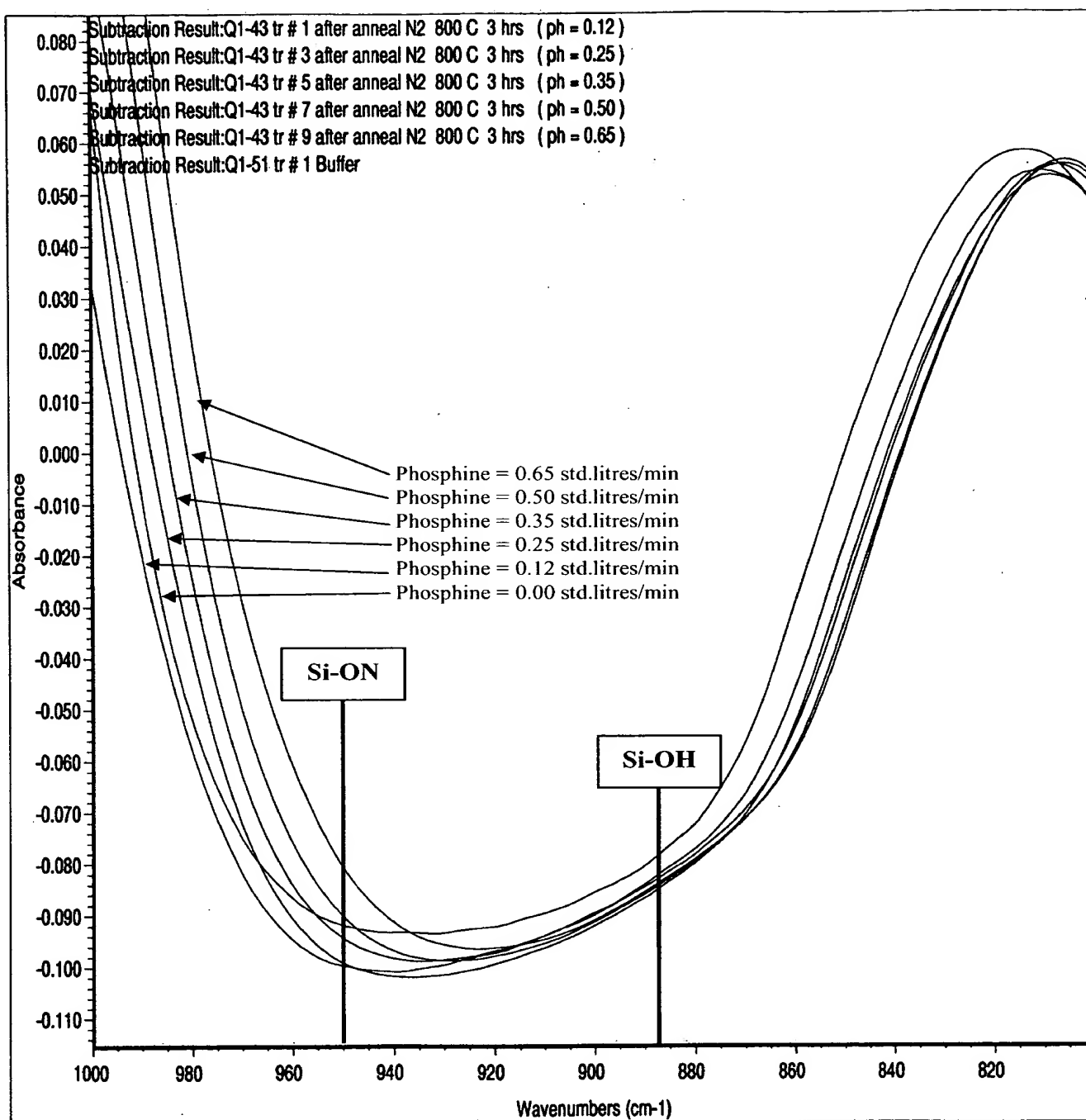


Figure 4d

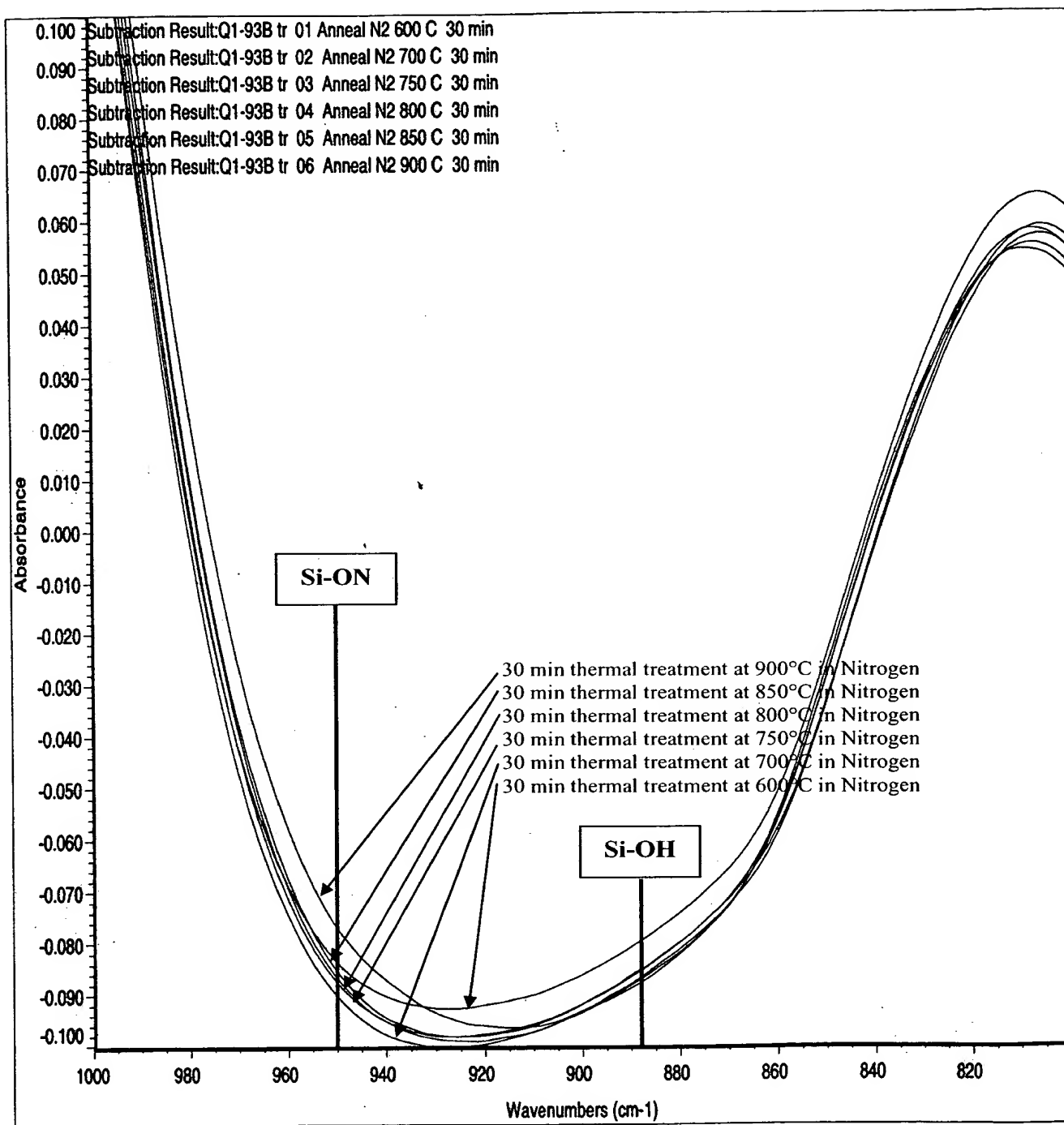


Figure 5c

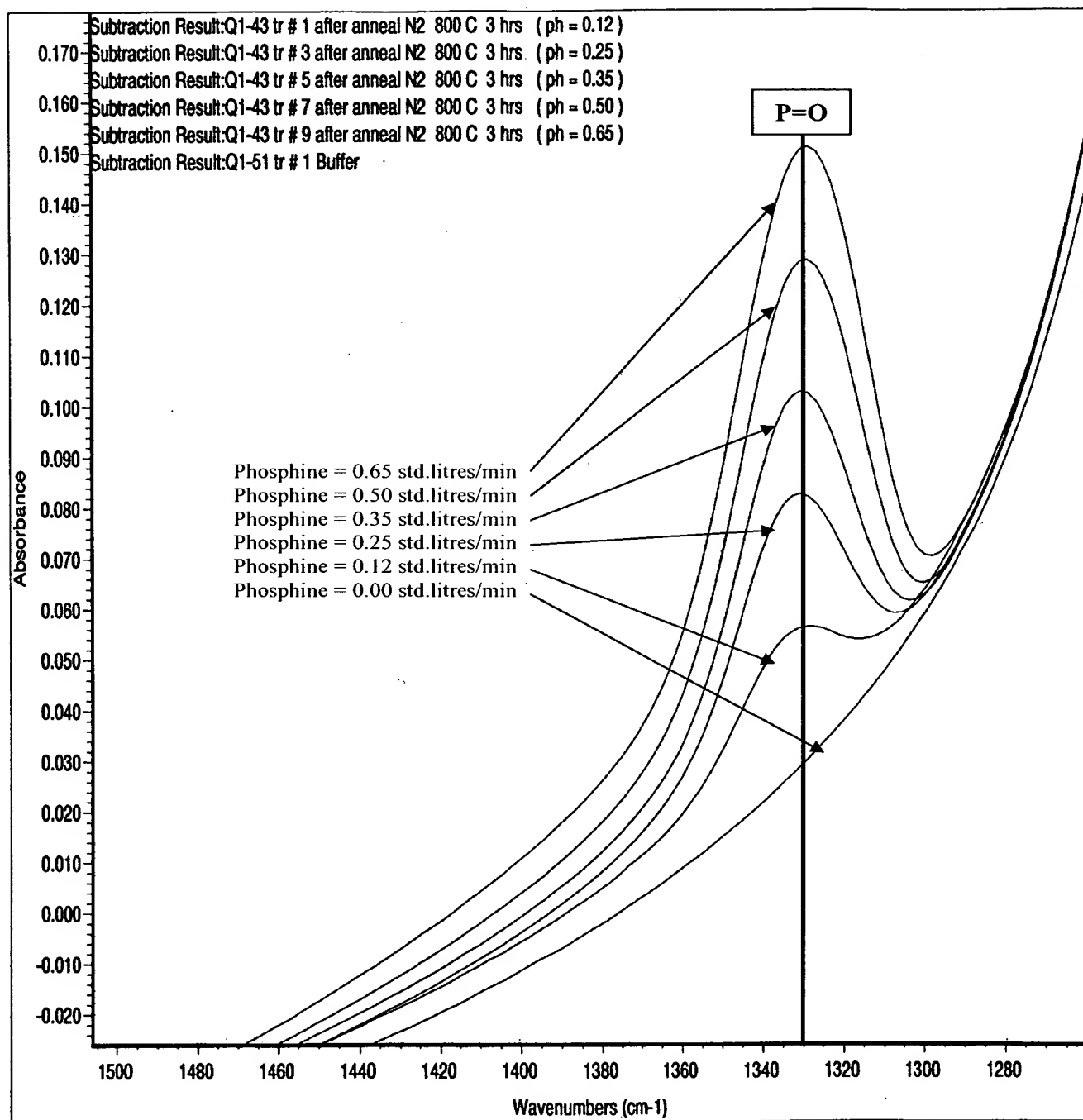


Figure 5d

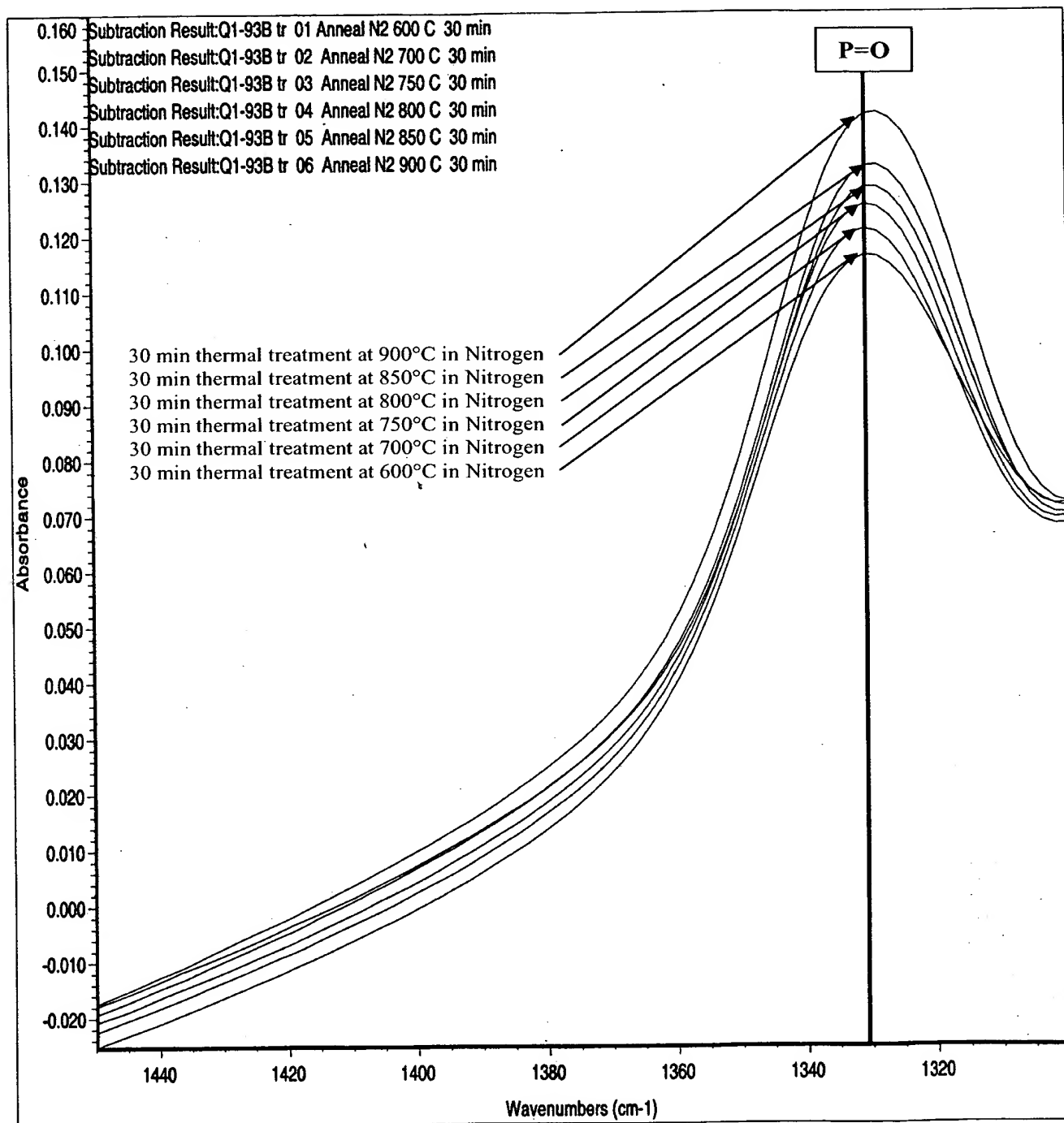


Figure 6a

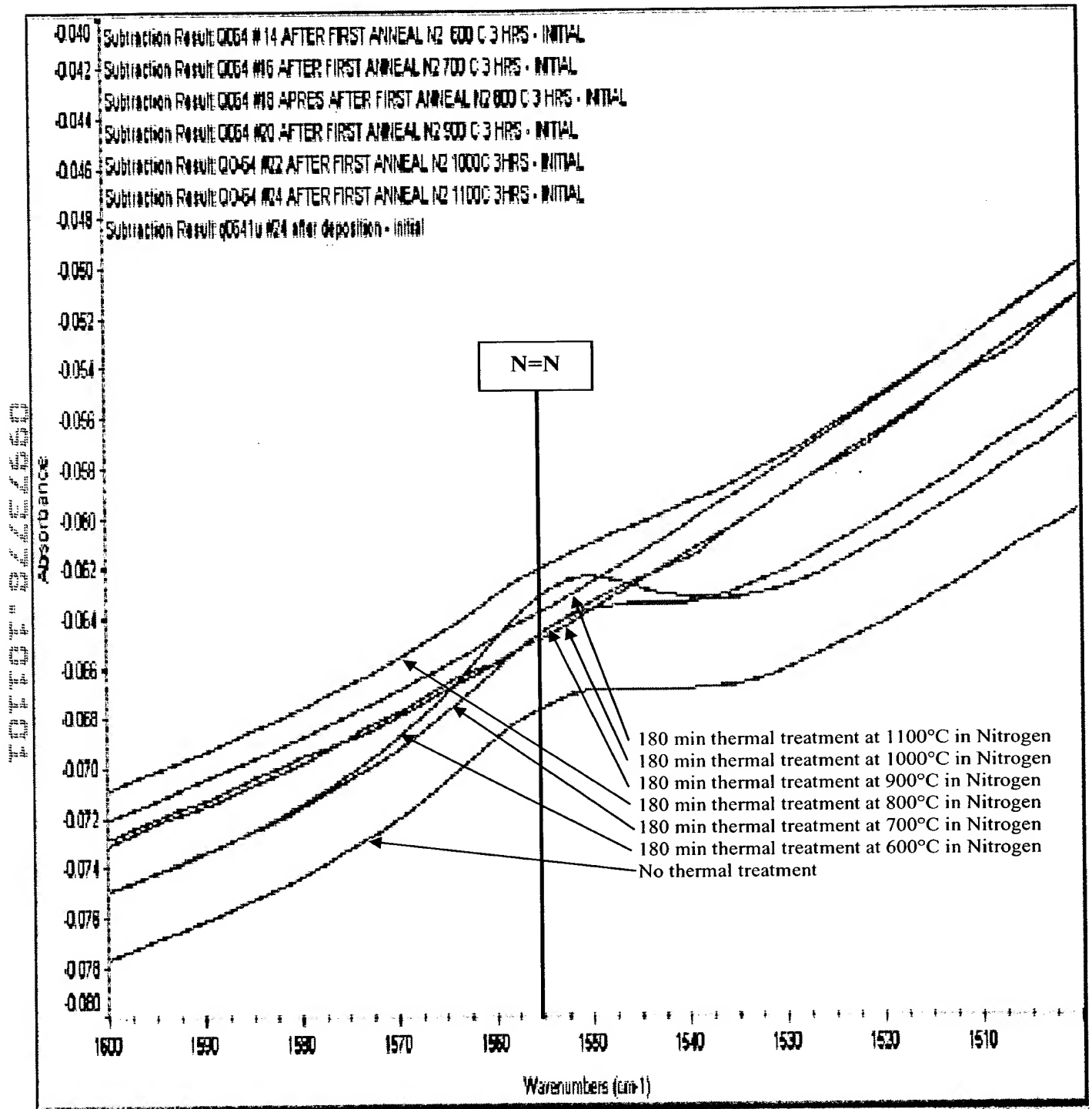


Figure 6b

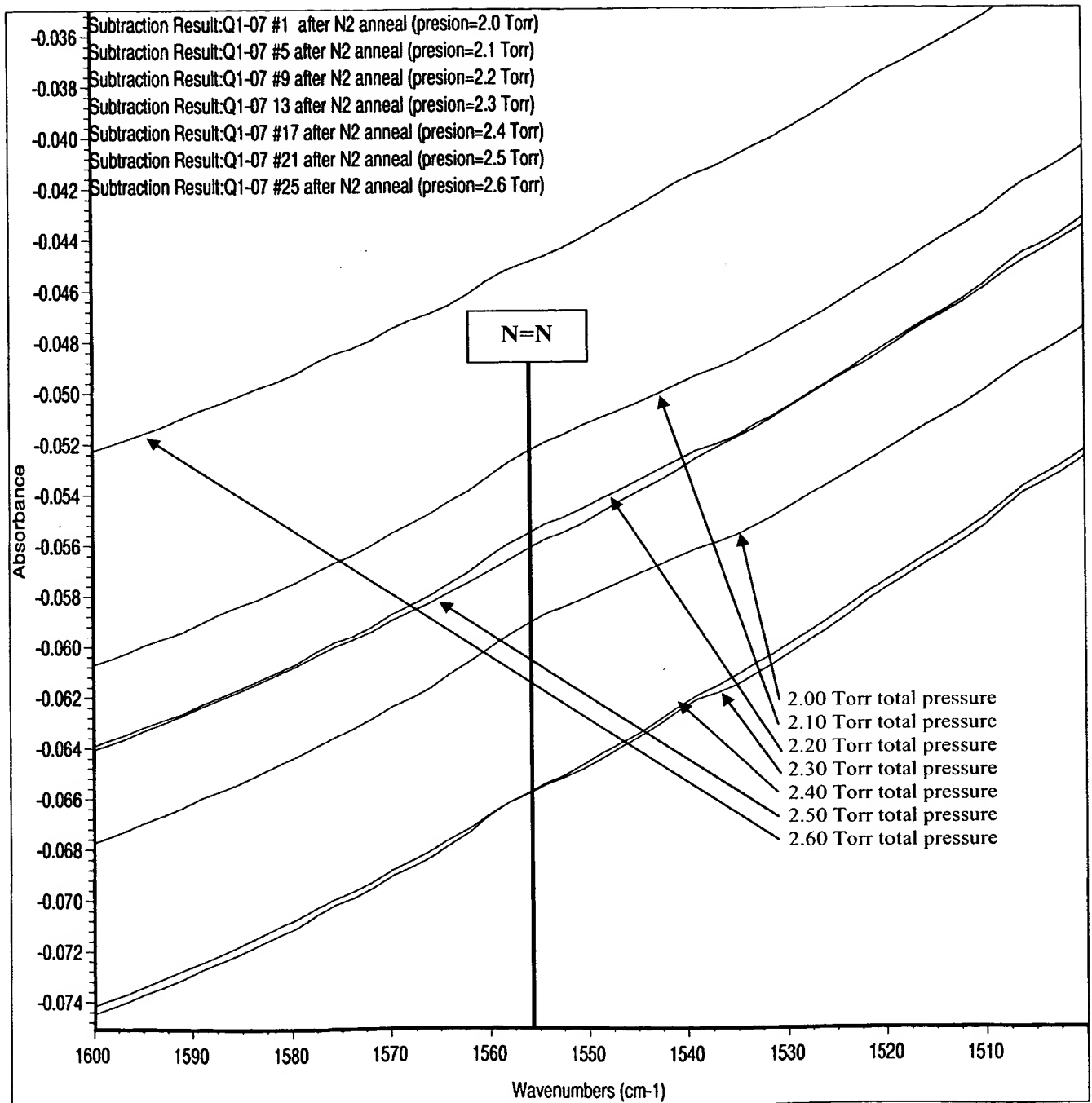


Figure 6c

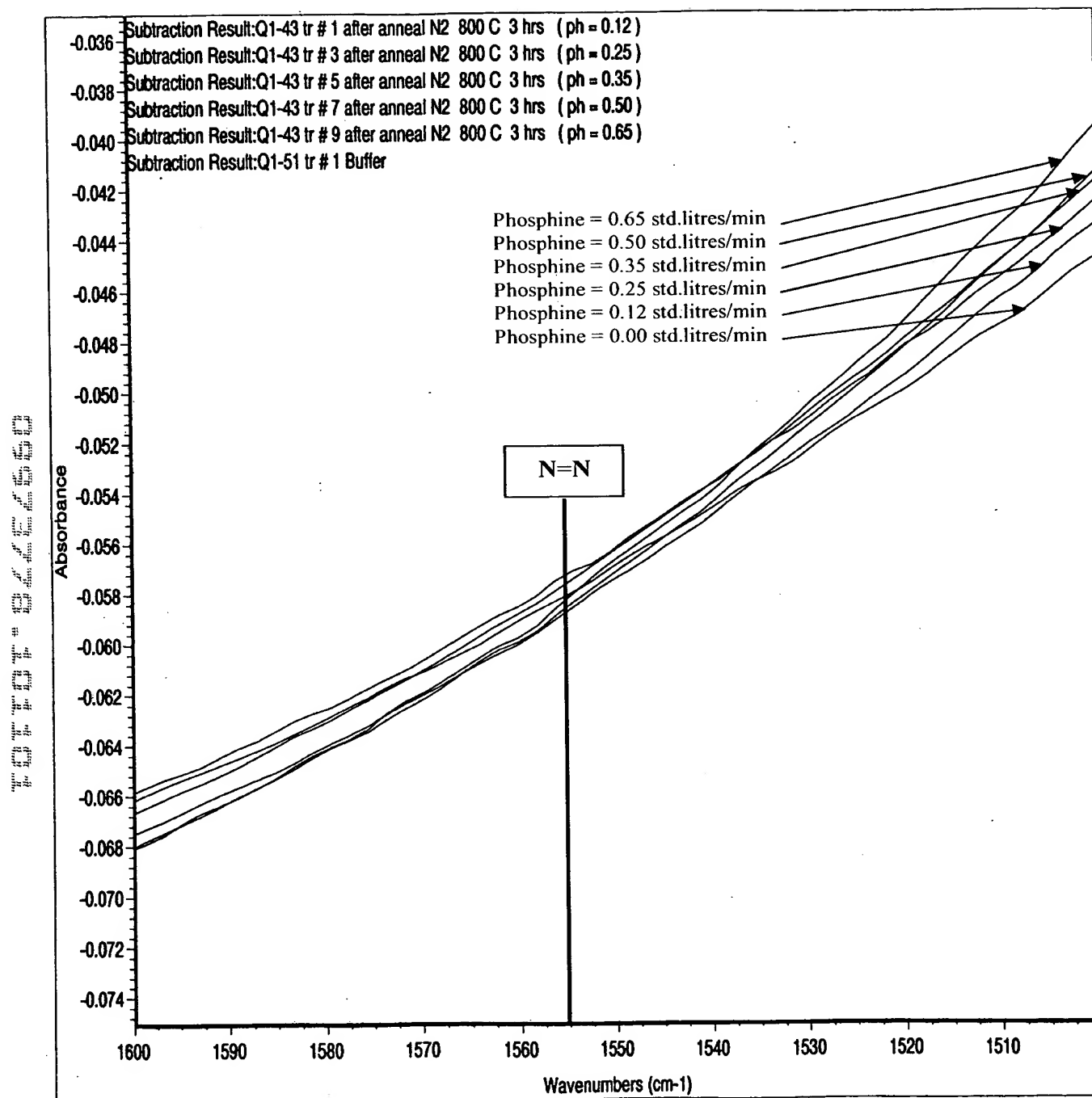


Figure 6d

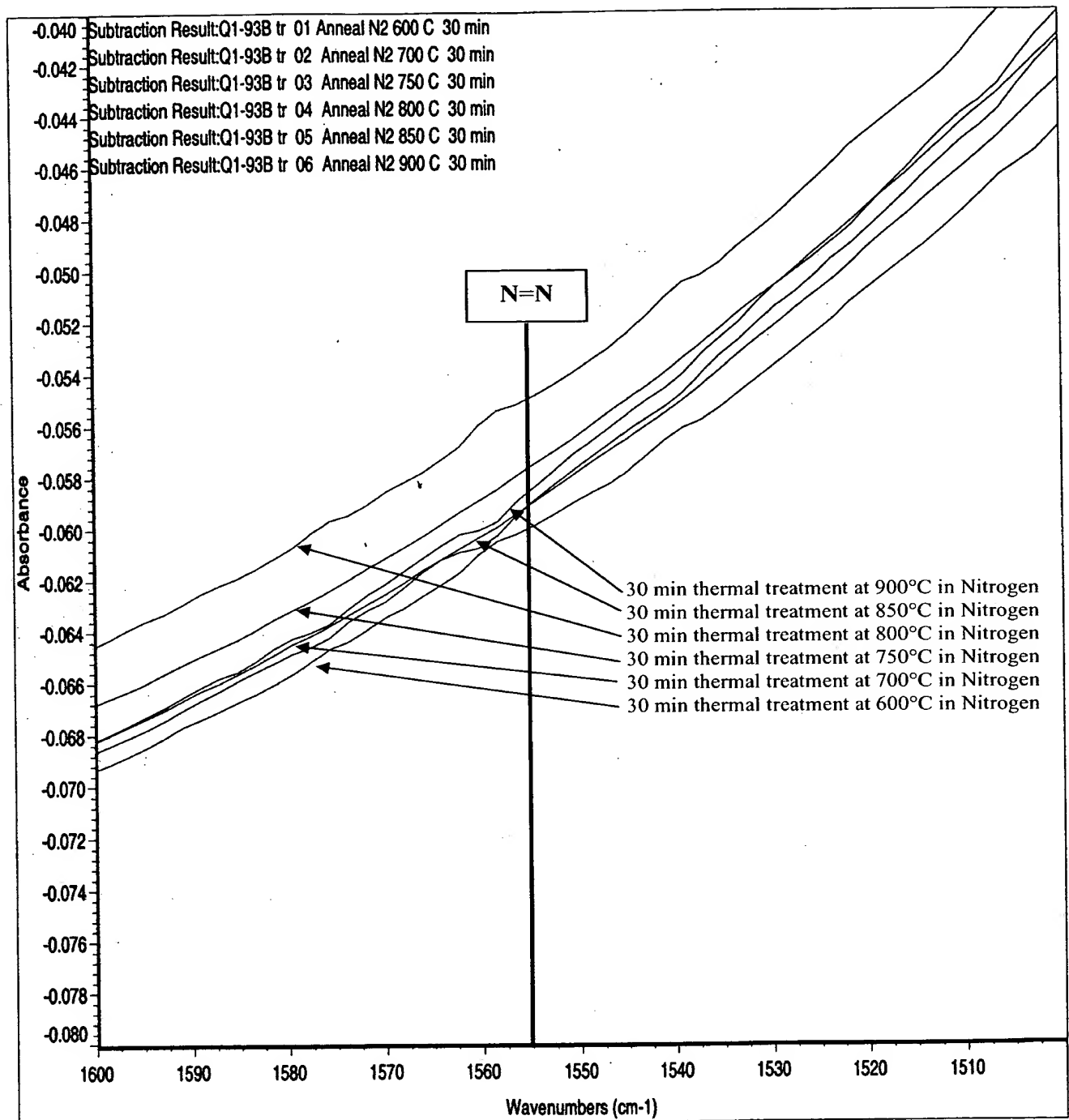


Figure 7a

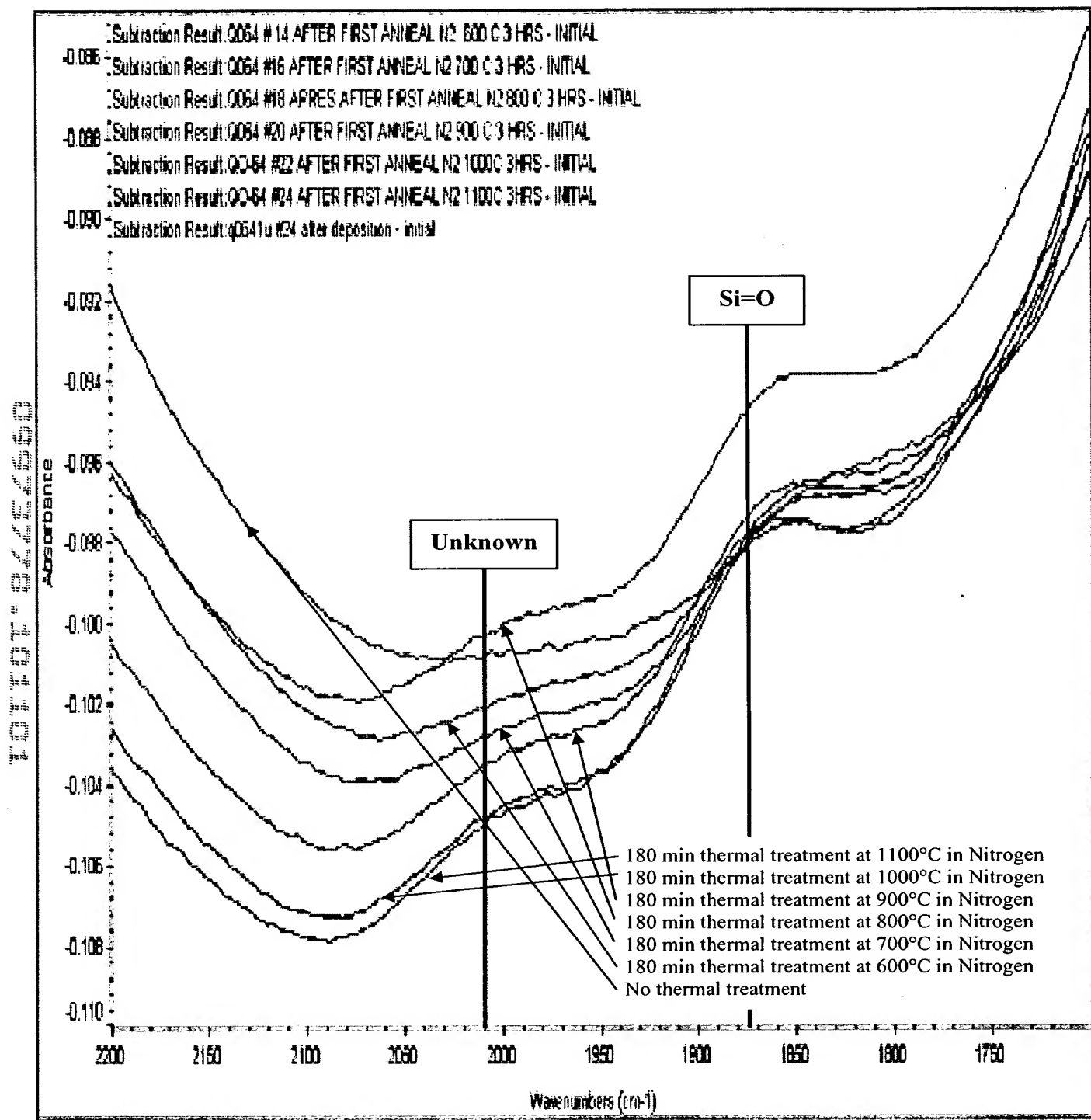


Figure 7b

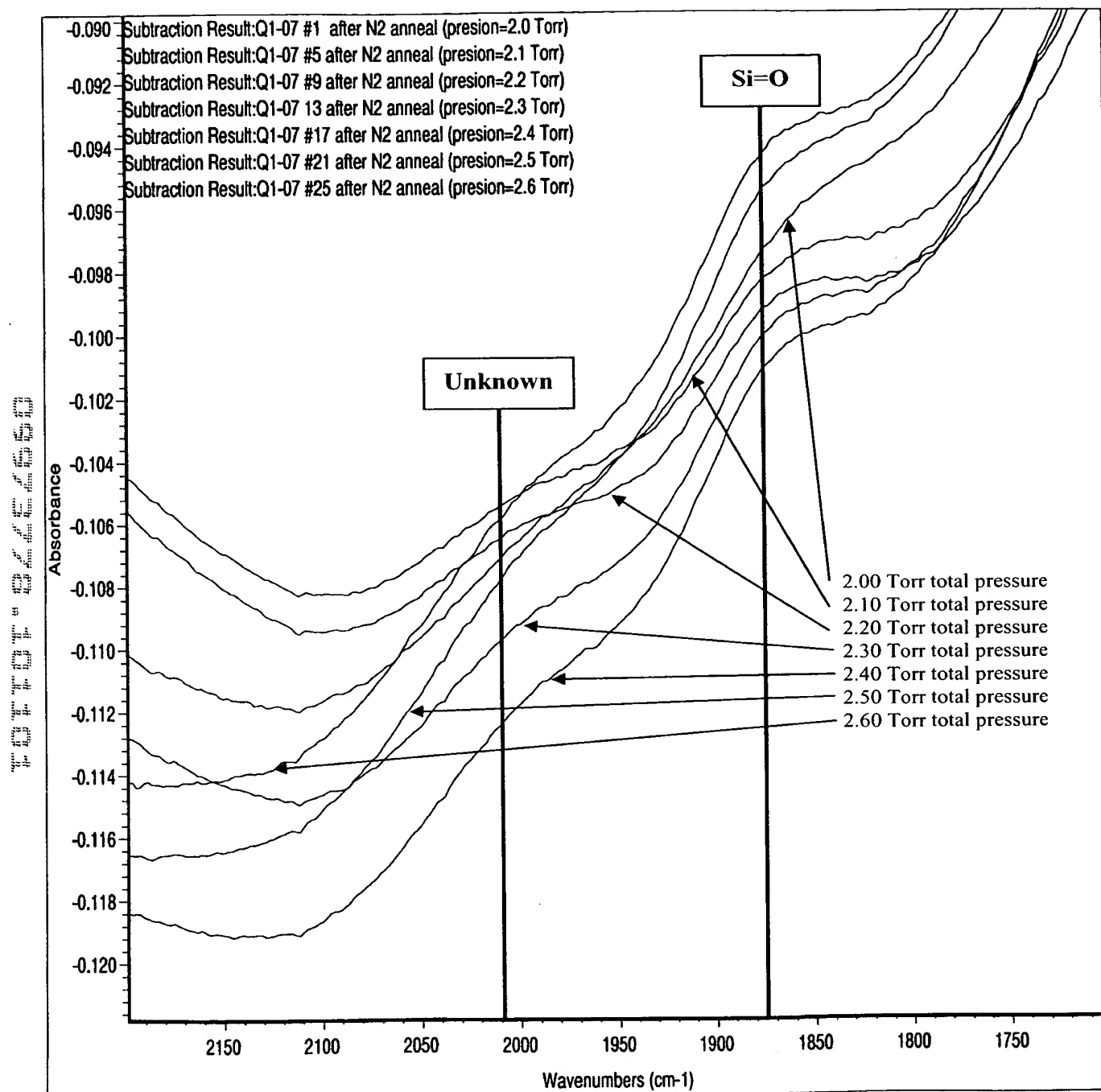


Figure 7c

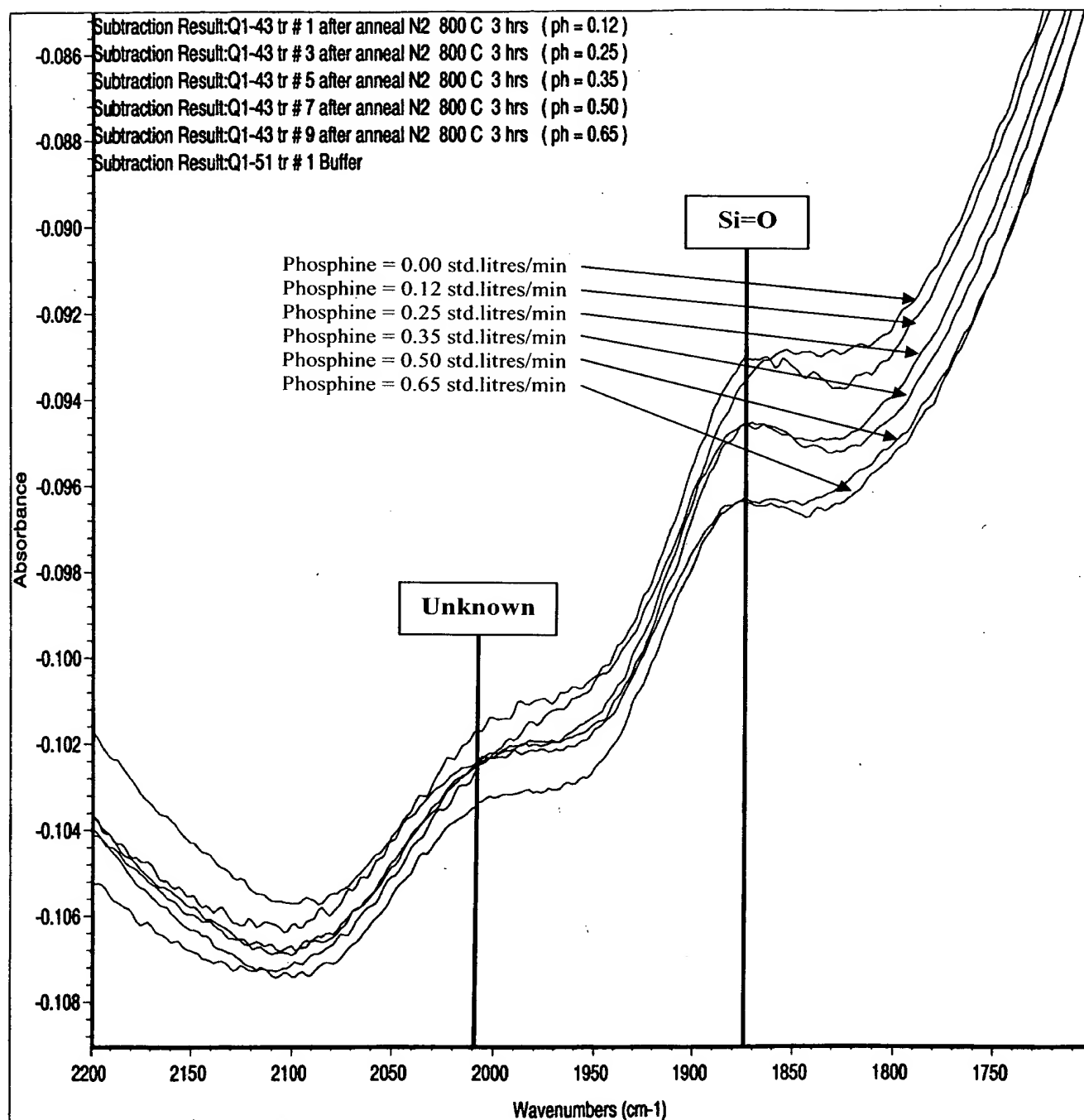


Figure 7d

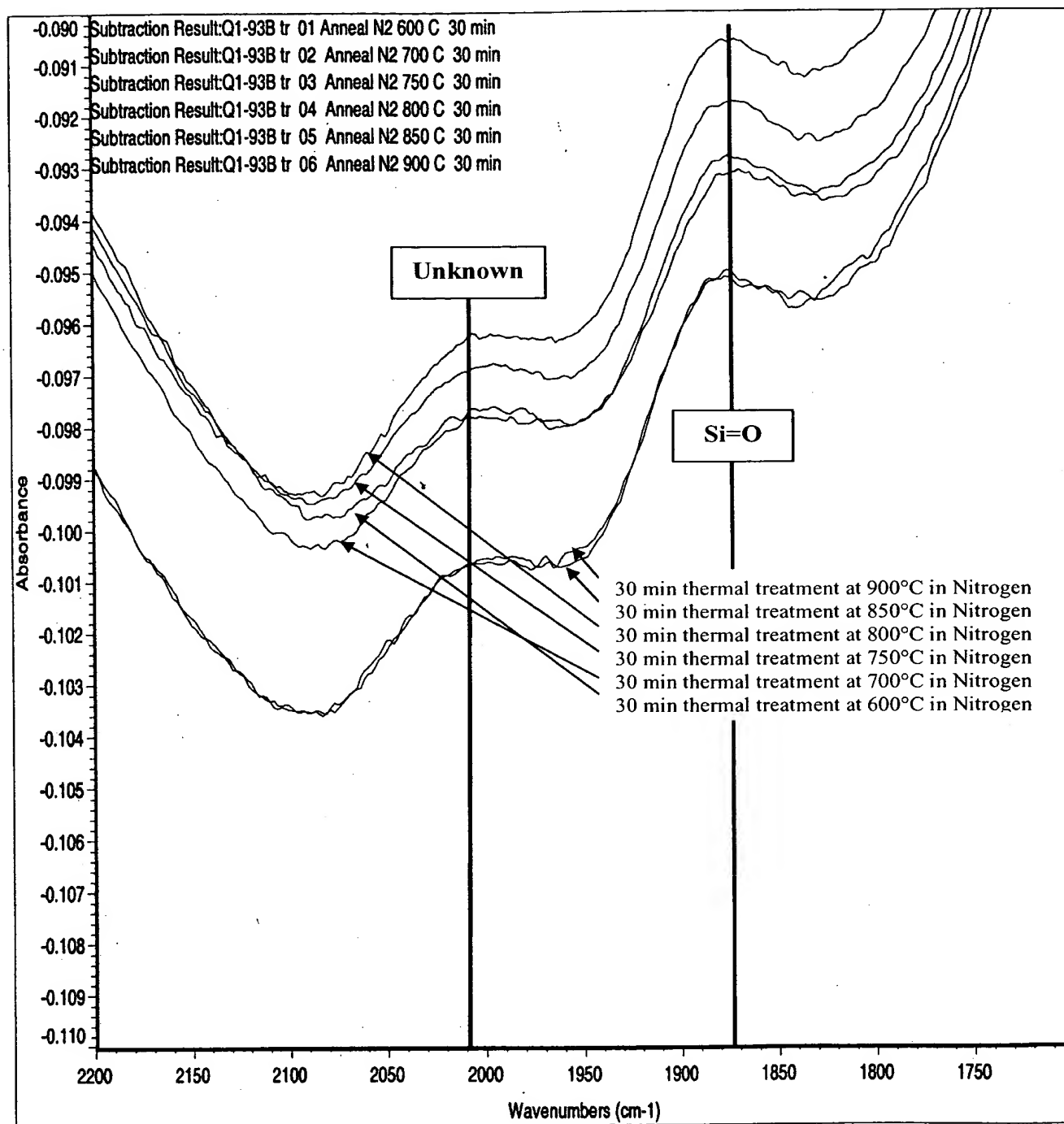


Figure 8a

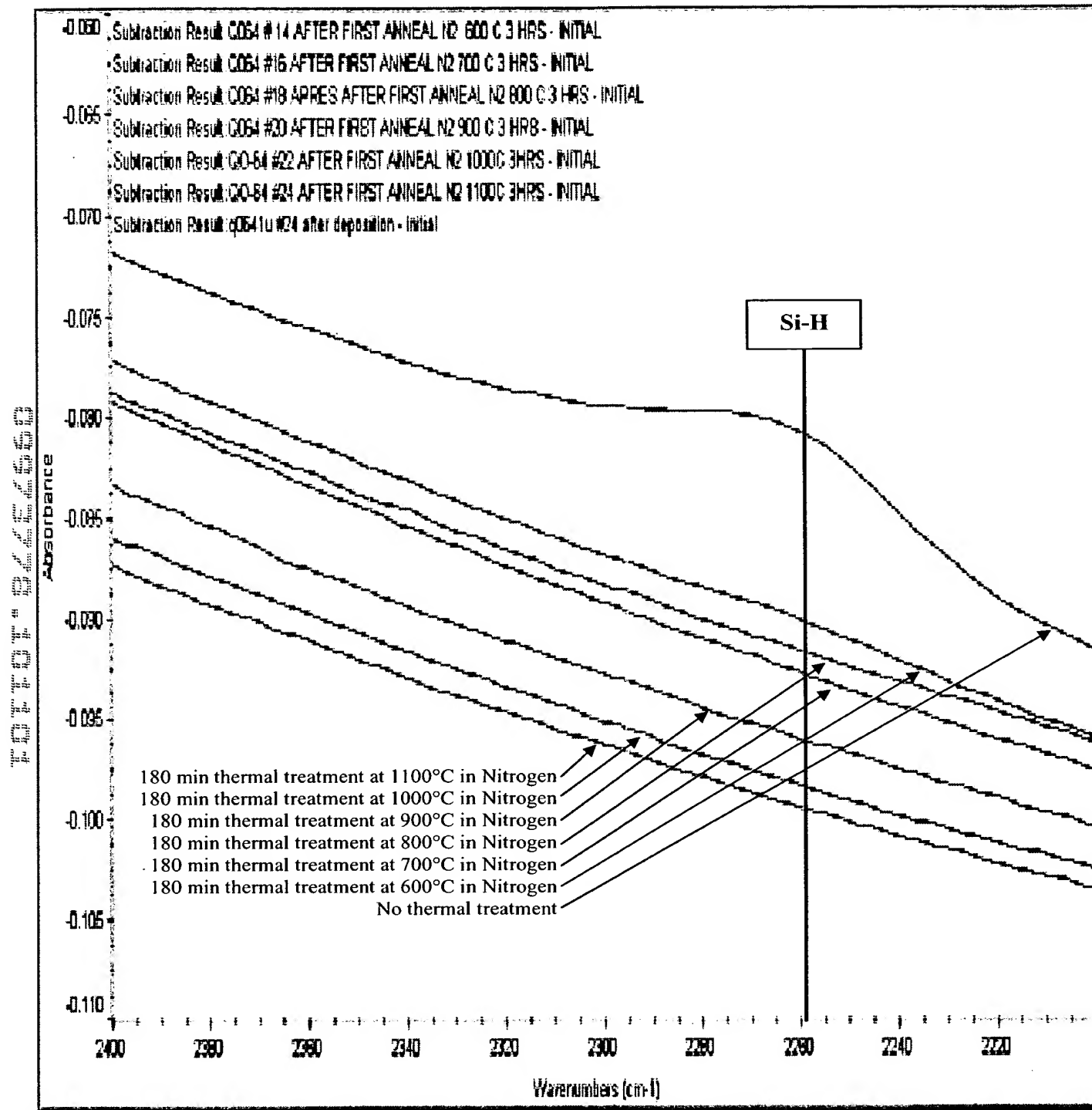


Figure 8b

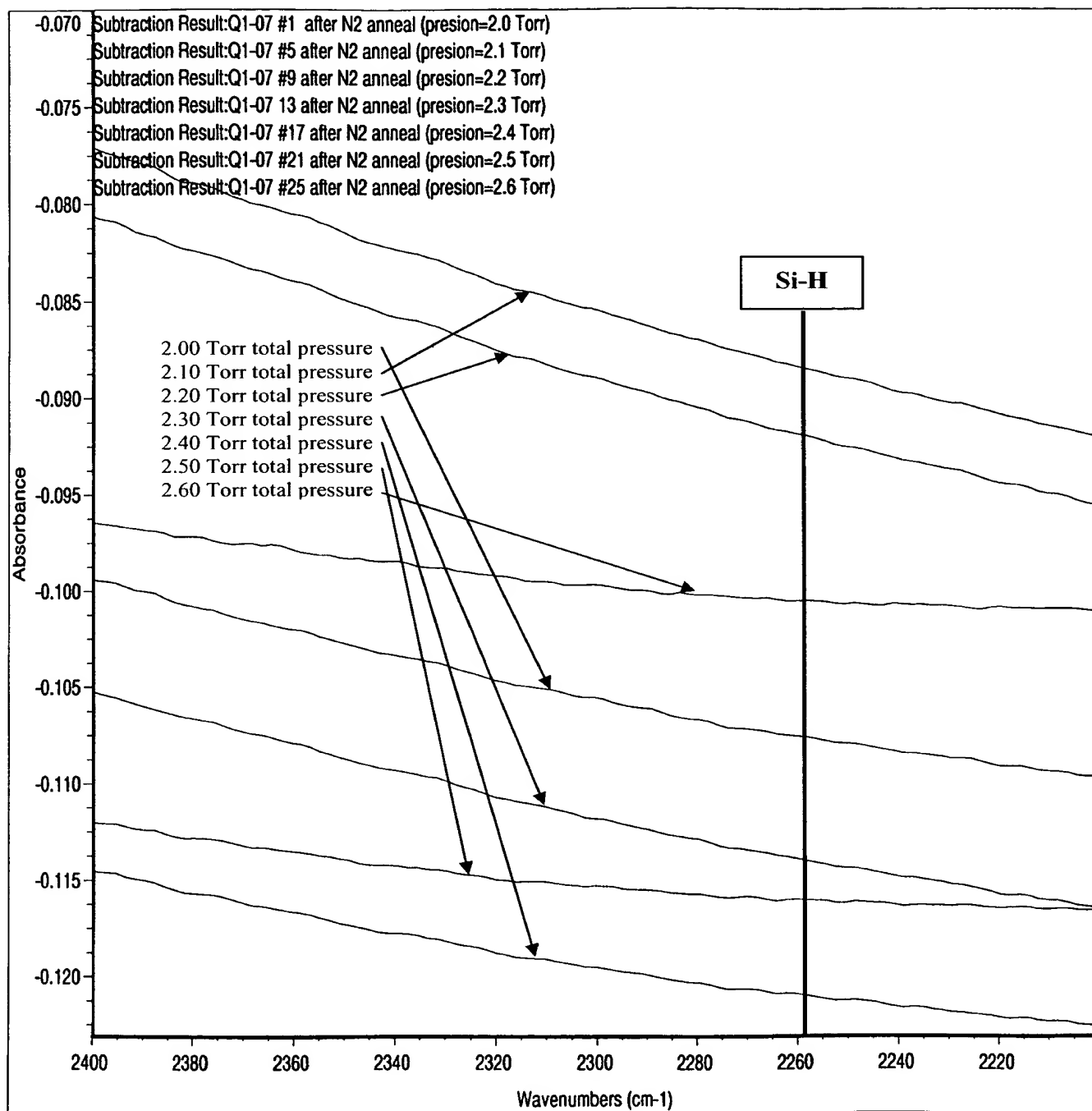


Figure 8c

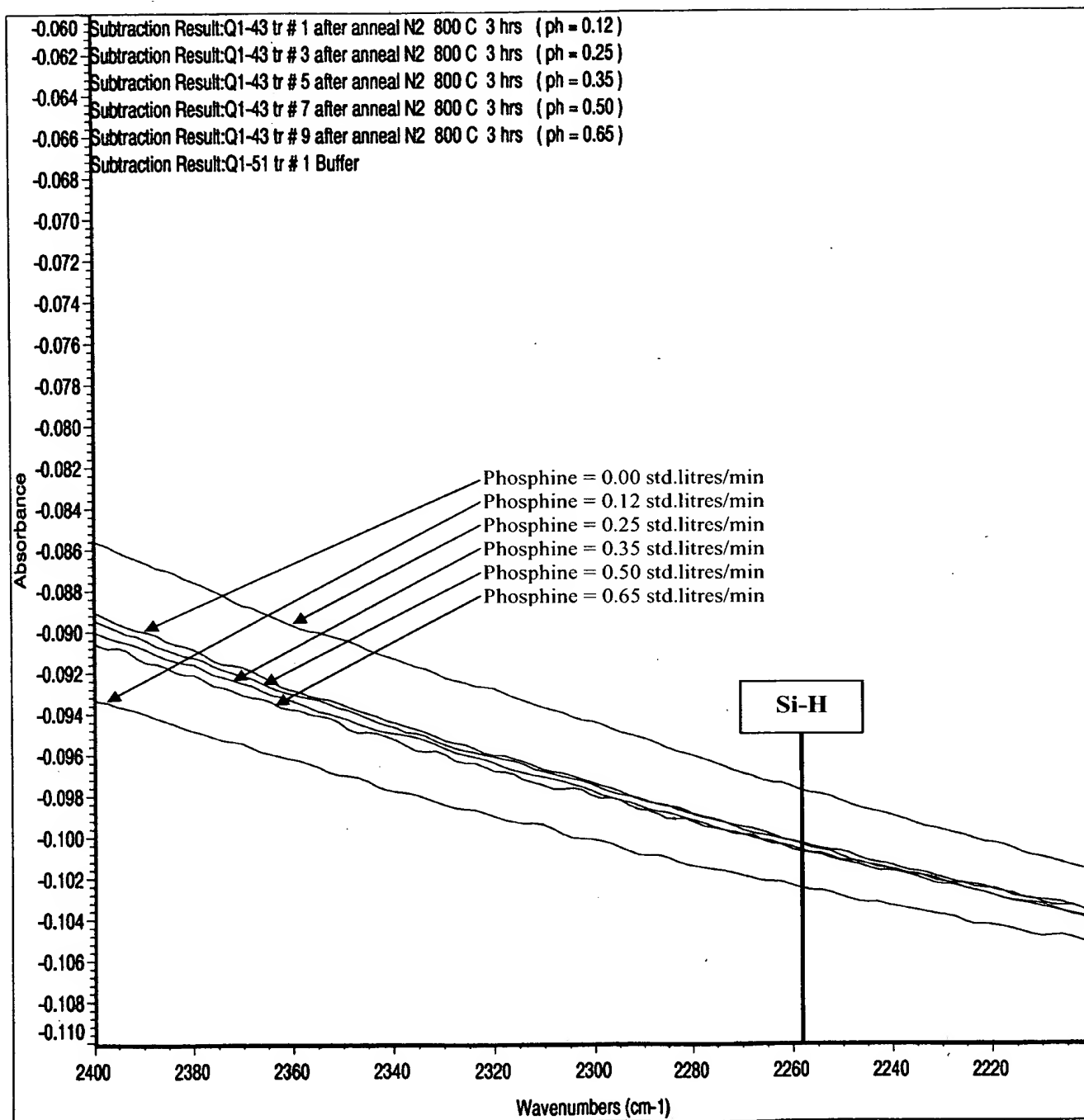


Figure 8d

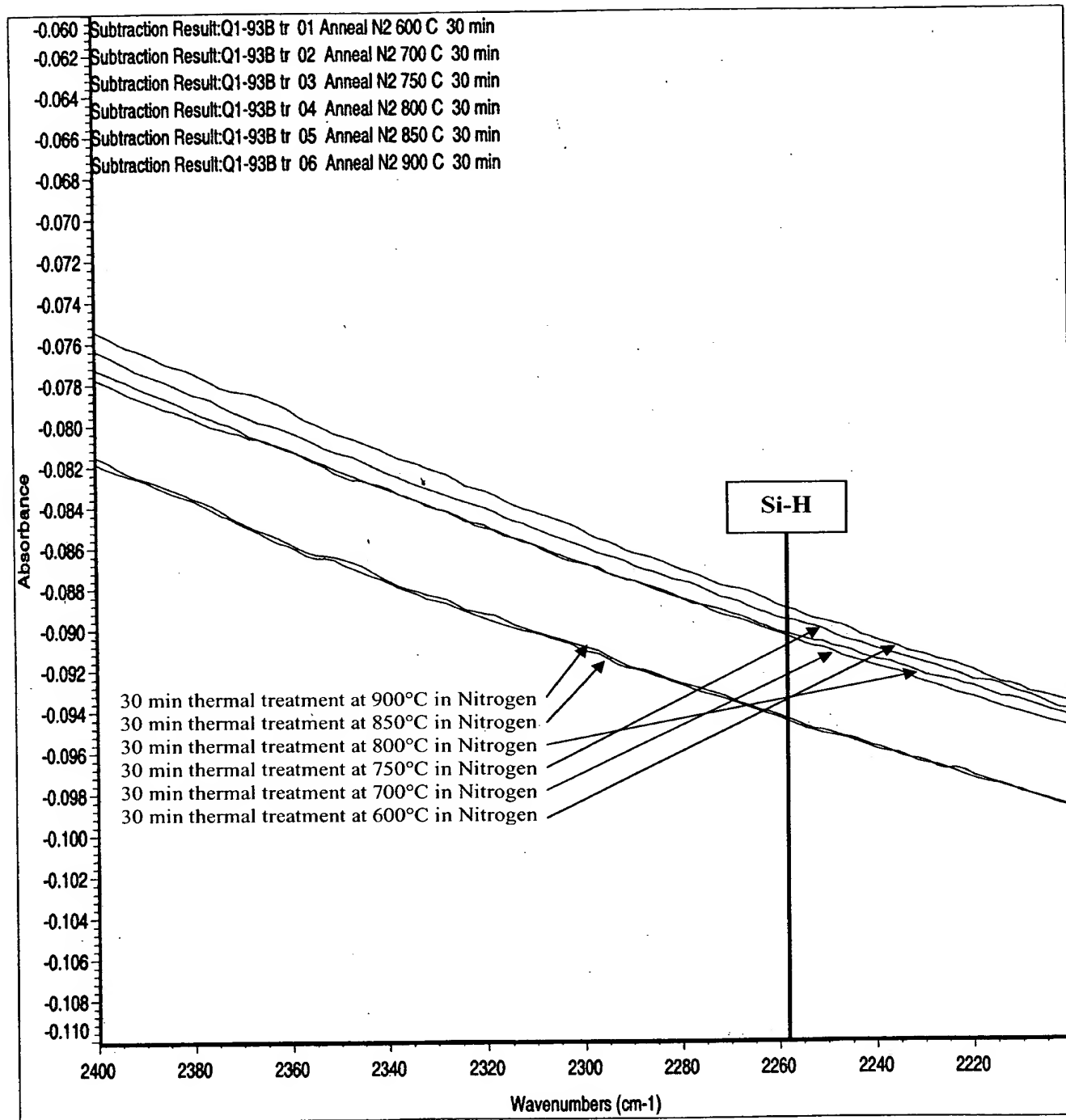


Figure 9a

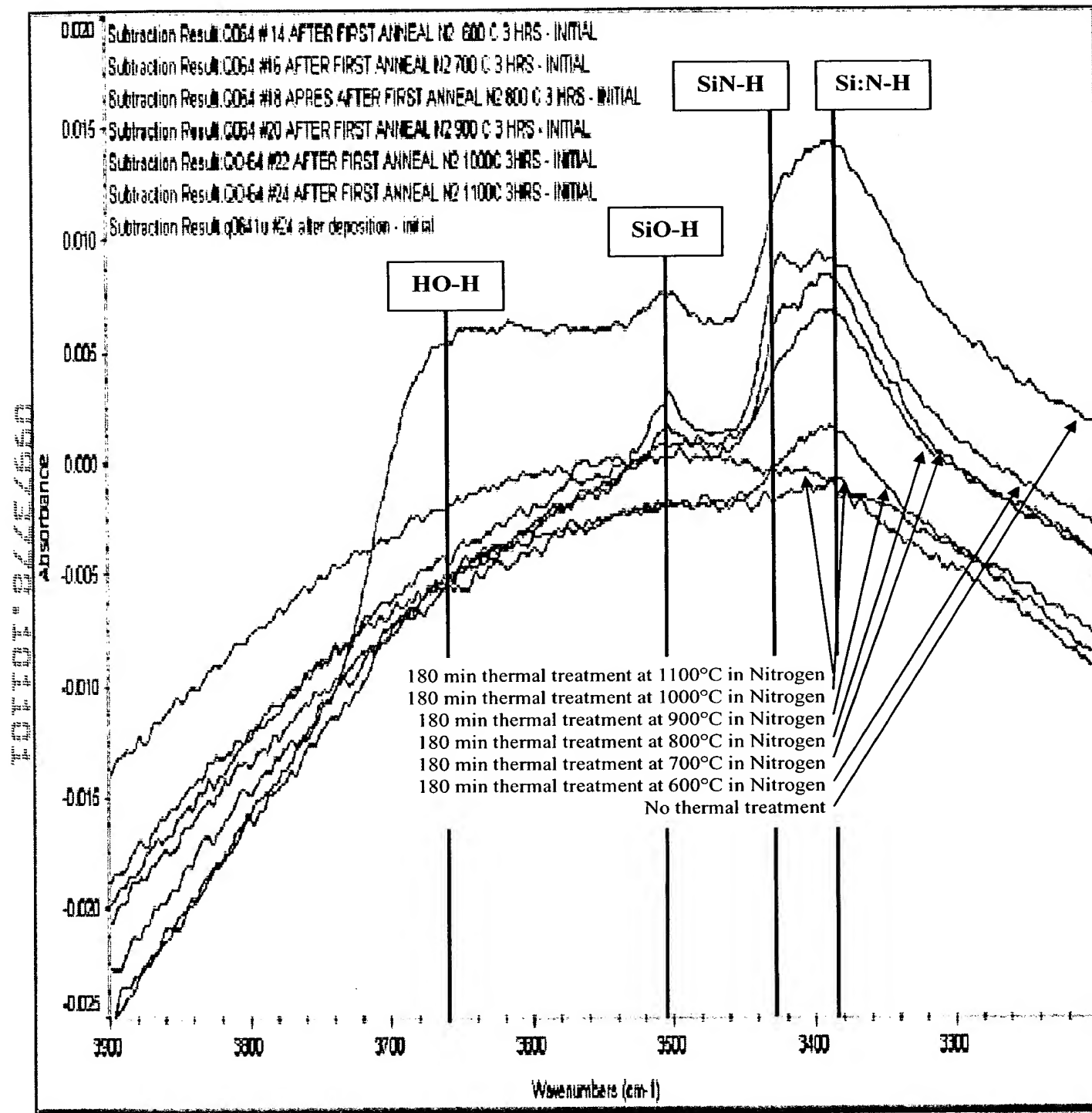


Figure 9b

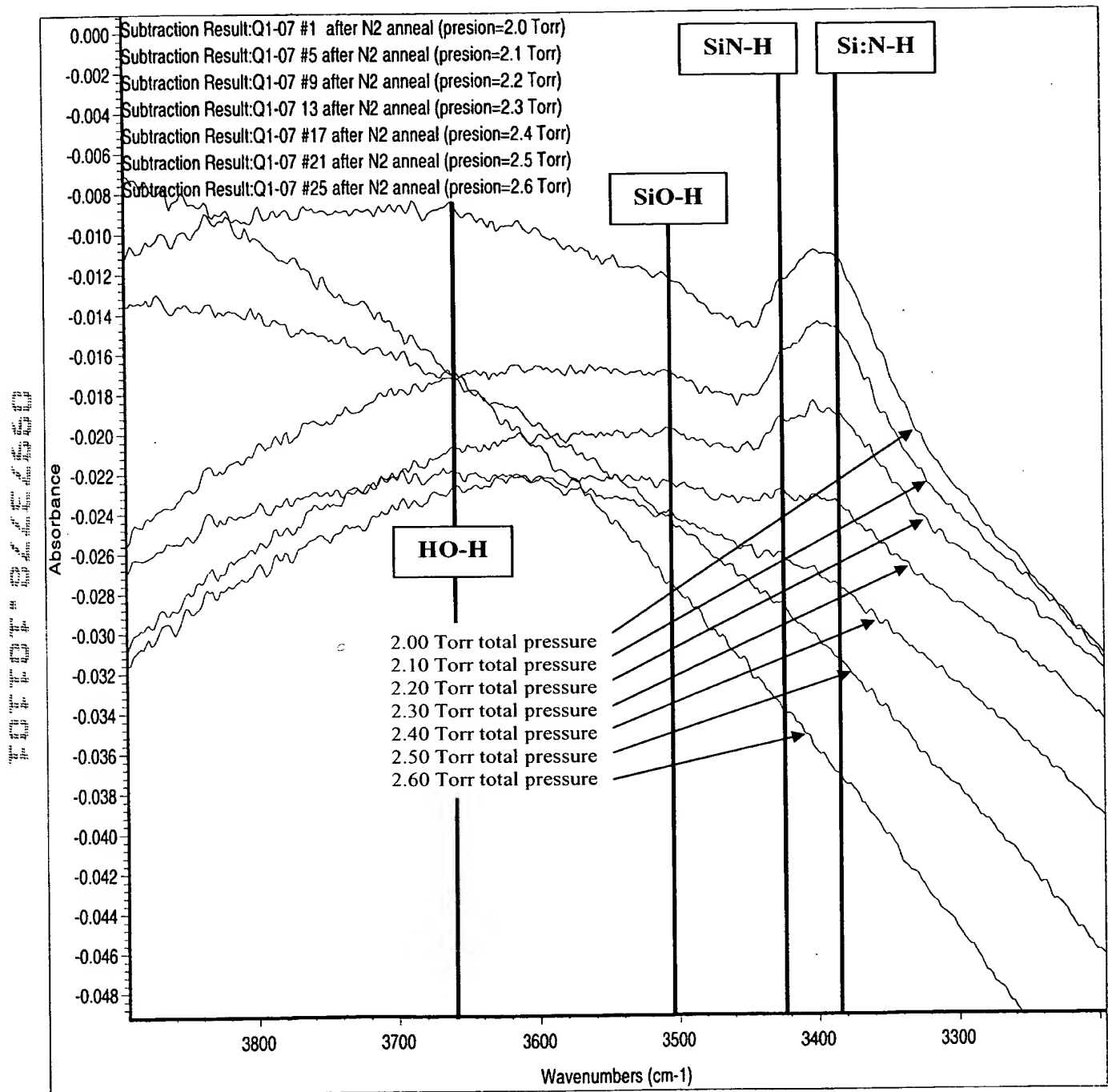


Figure 9c

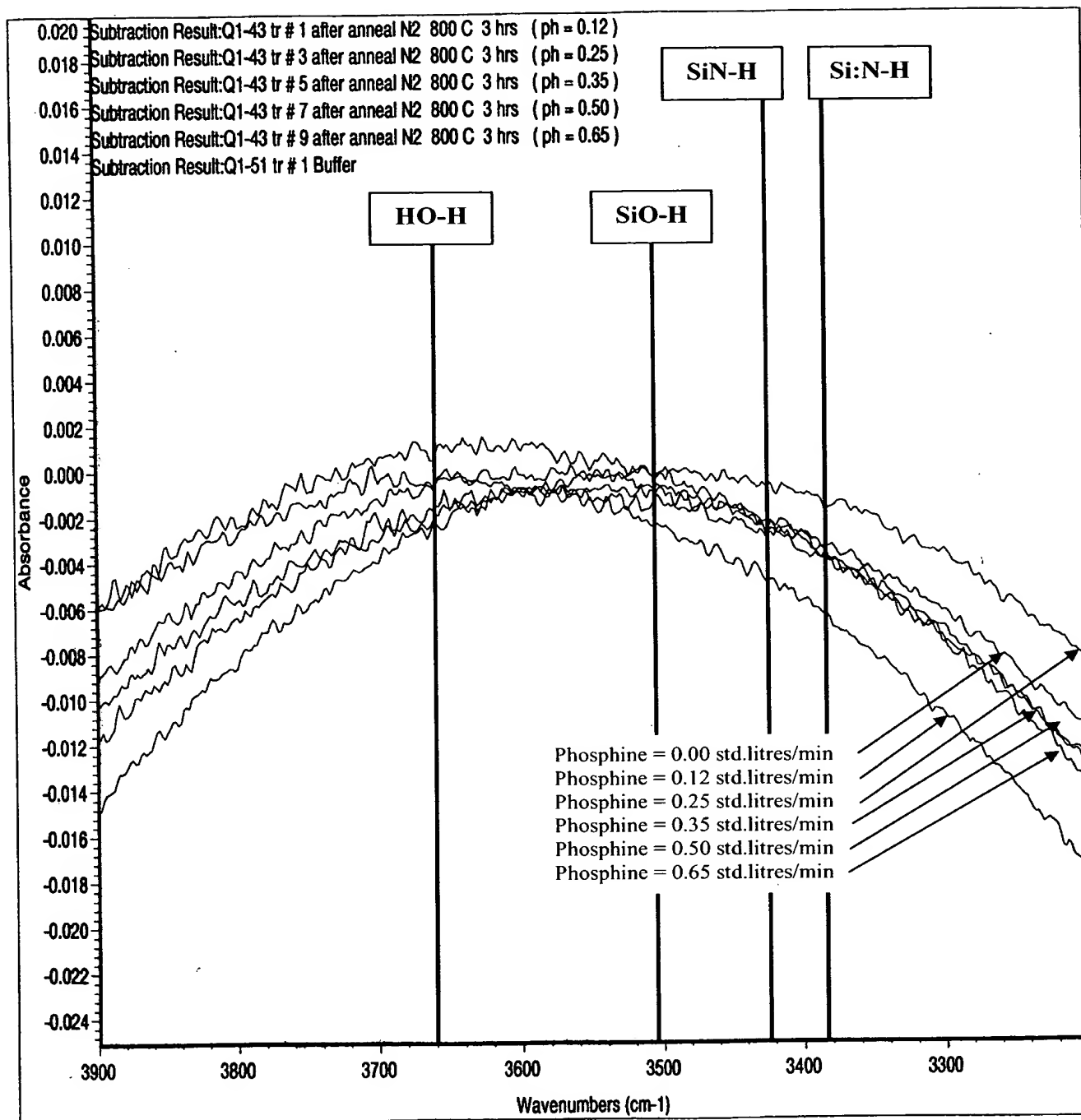


Figure 9d

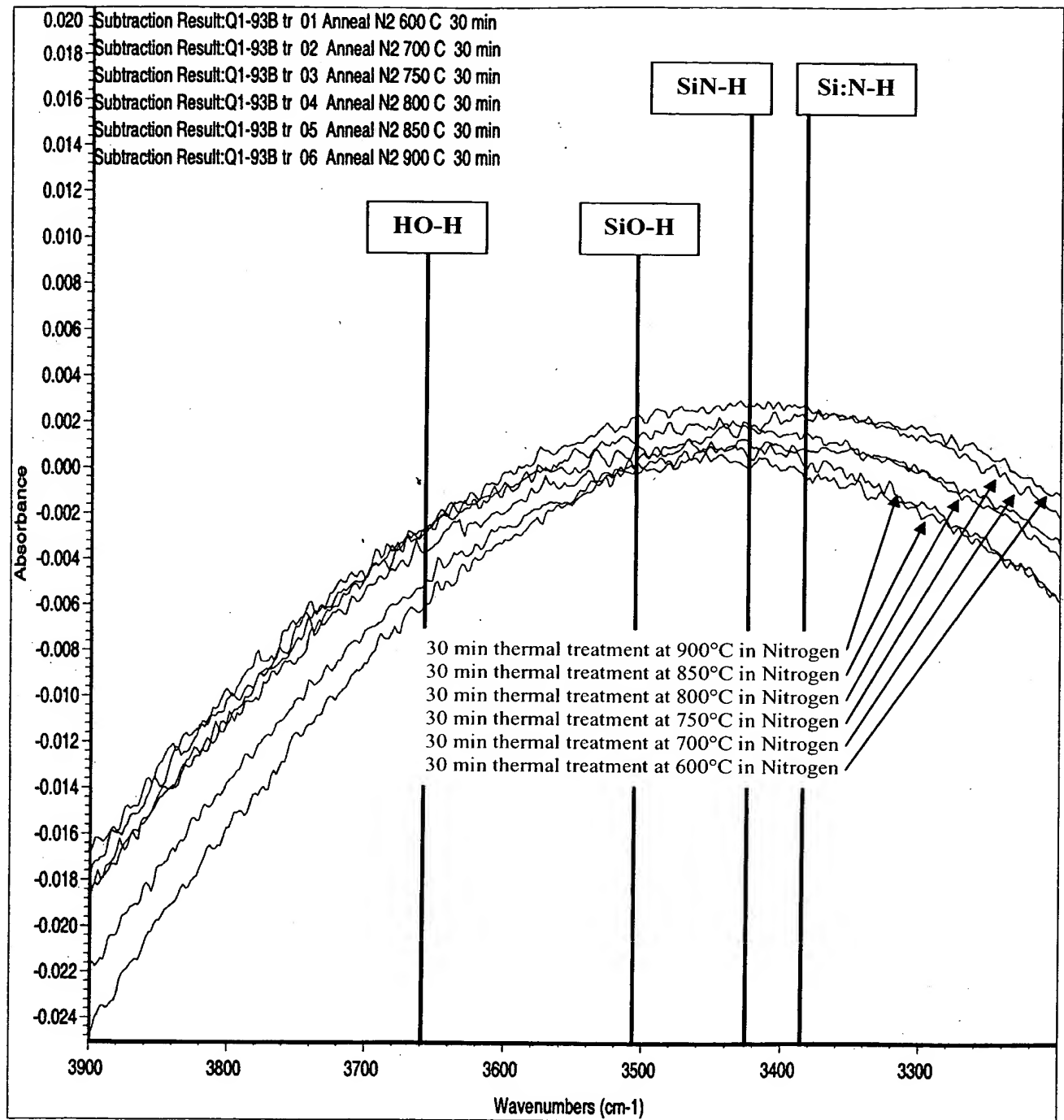


Figure 10

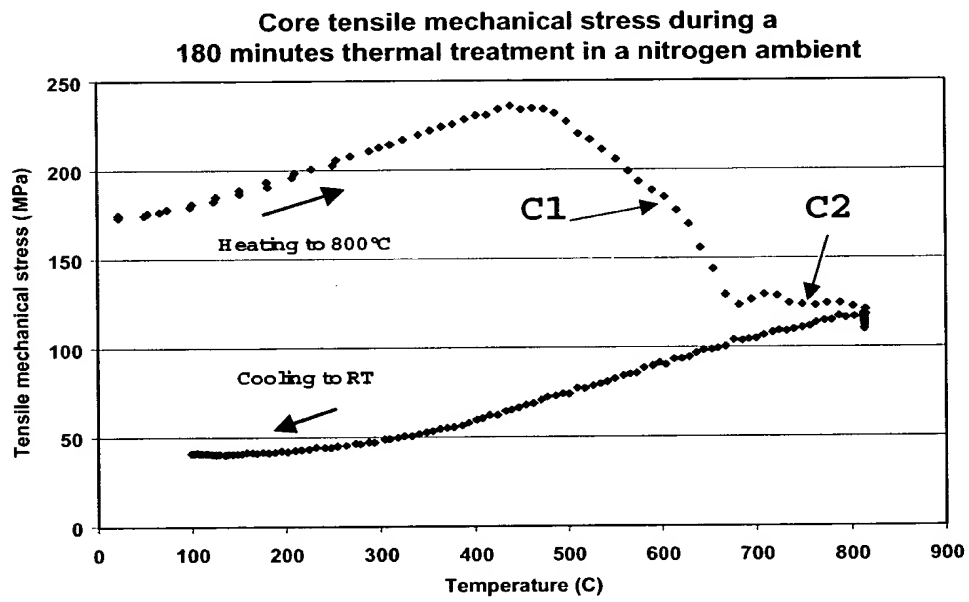
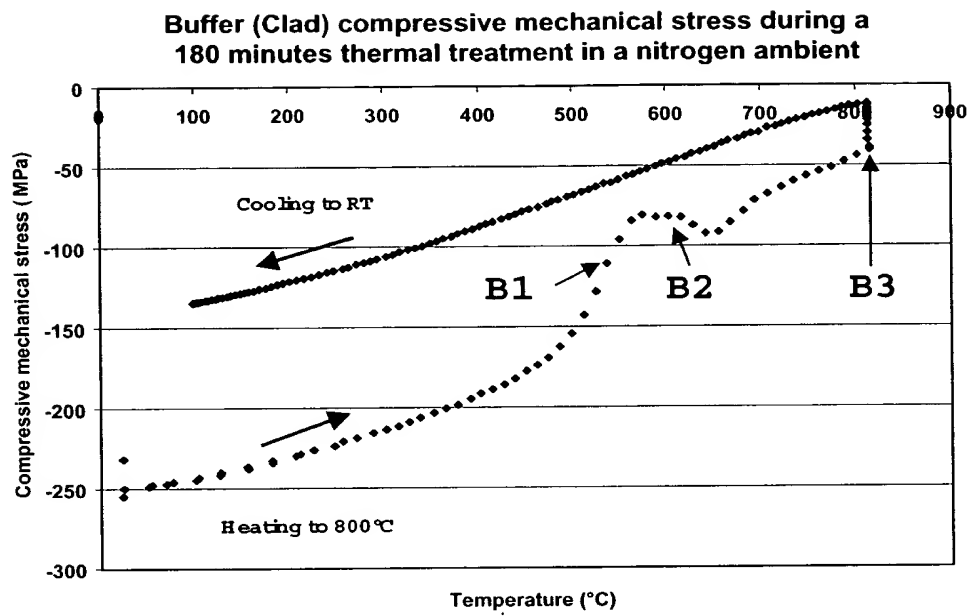


Figure 11

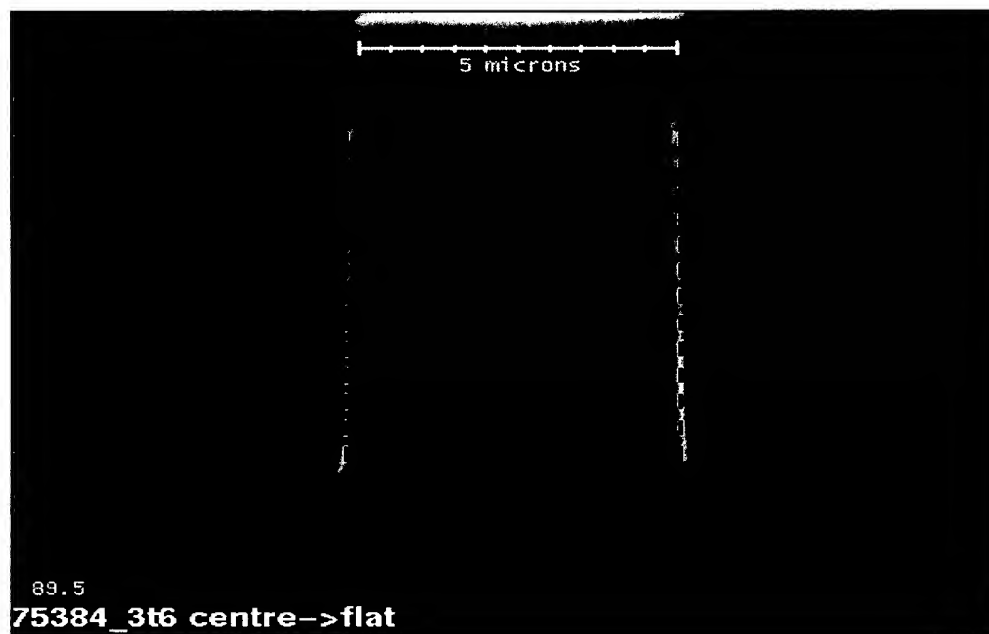
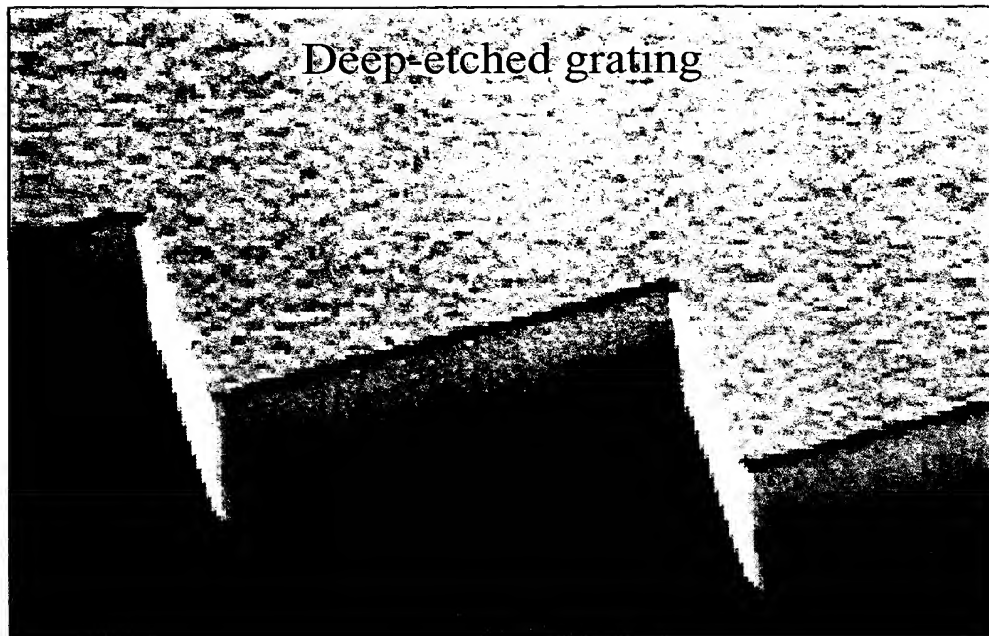


Figure 12

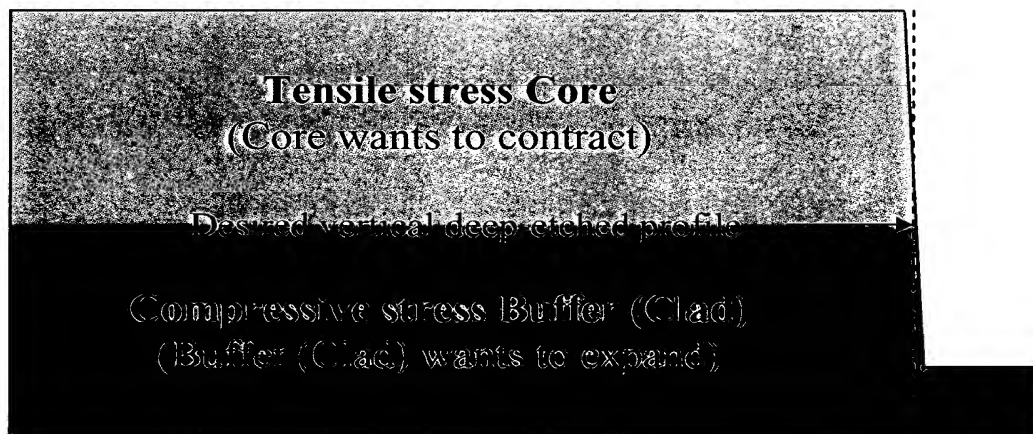
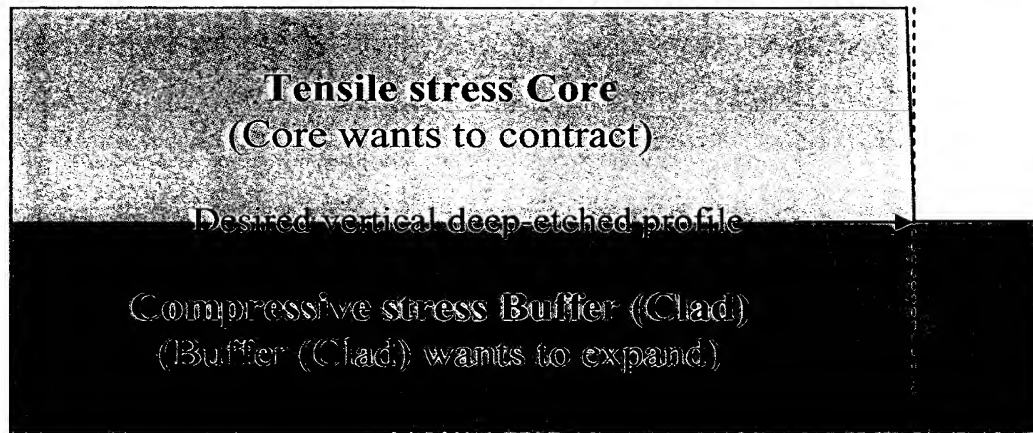
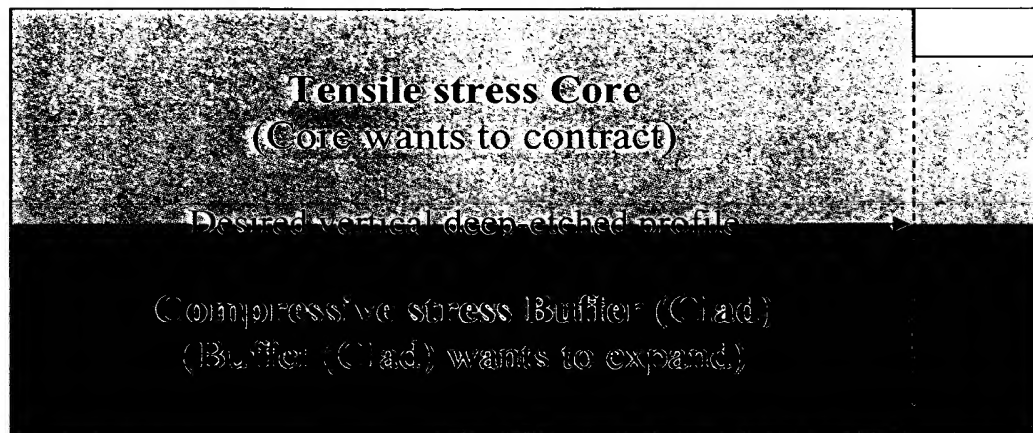
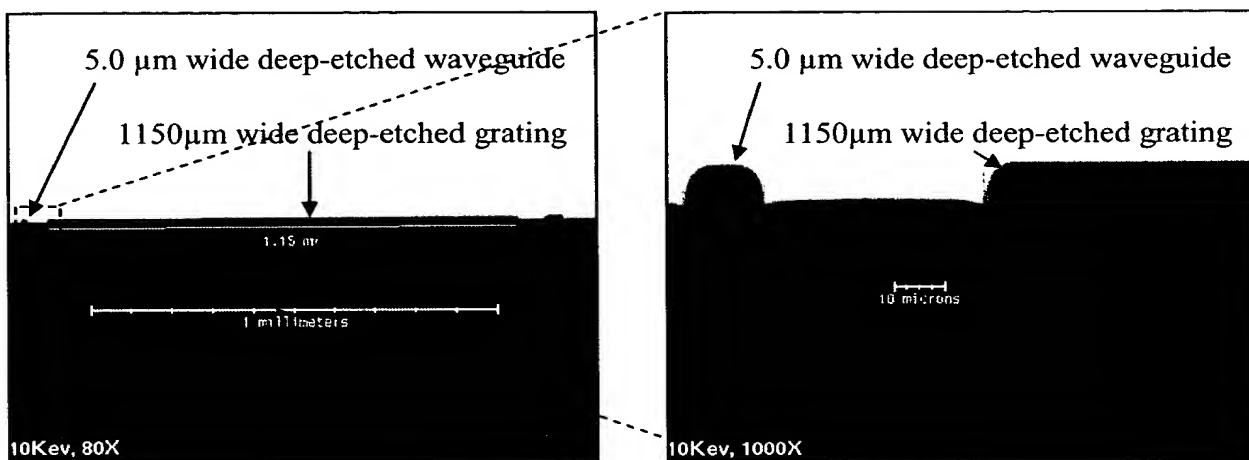
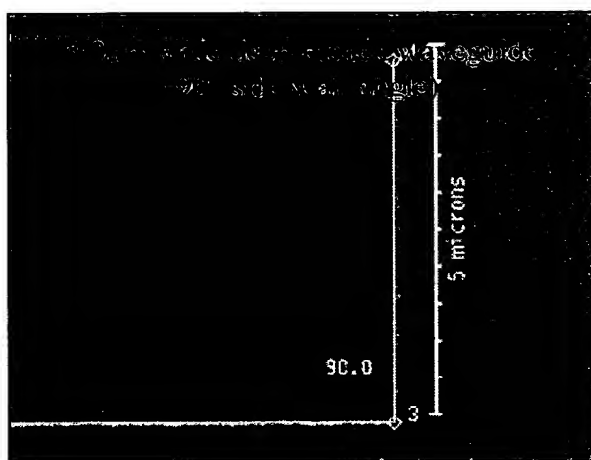


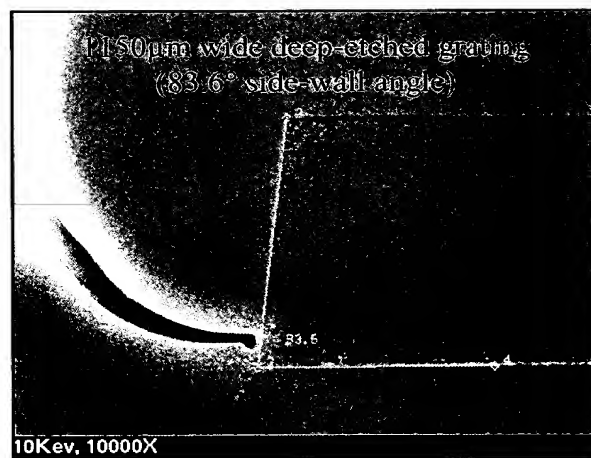
Figure 13



The relative position between an isolated 5.0 μm wide deep-etched waveguide and its neighboring 1150 μm wide deep-etched grating at two different magnifications.



The side-wall of the 5.0 μm wide deep-etched waveguide facing the neighboring grating has a slope of about 90°.



The side-wall of the 1150 μm wide deep-etched grating facing the neighboring deep-etched waveguide has a much smaller slope of about 84°.

Figure 14

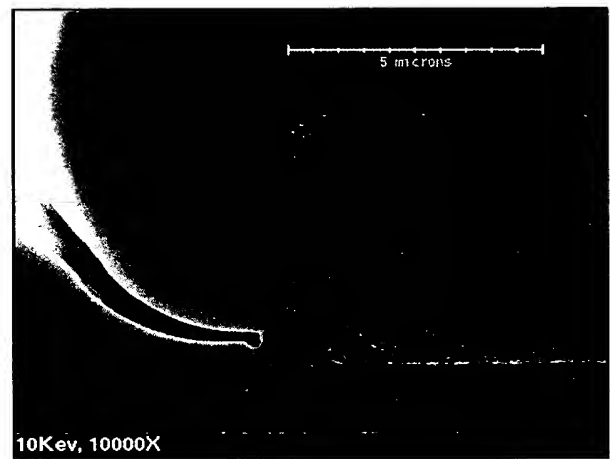
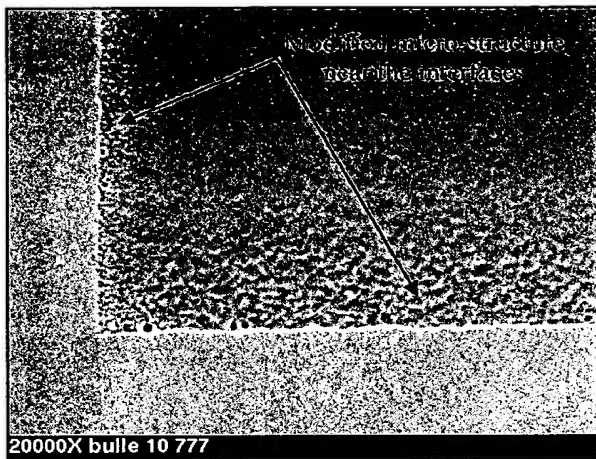
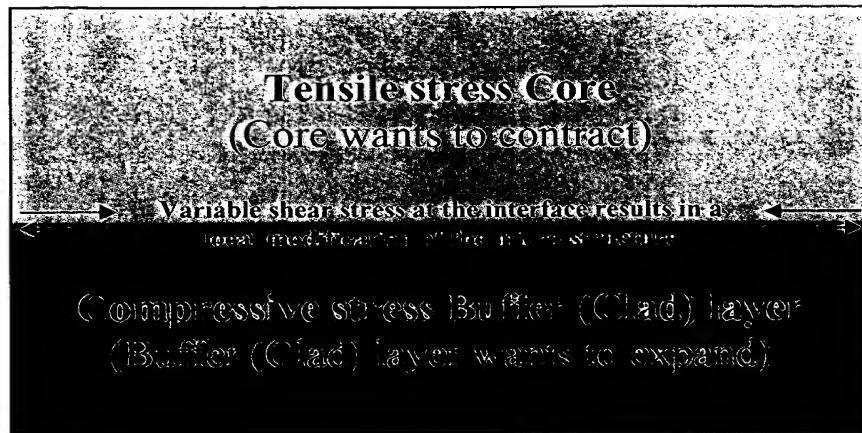
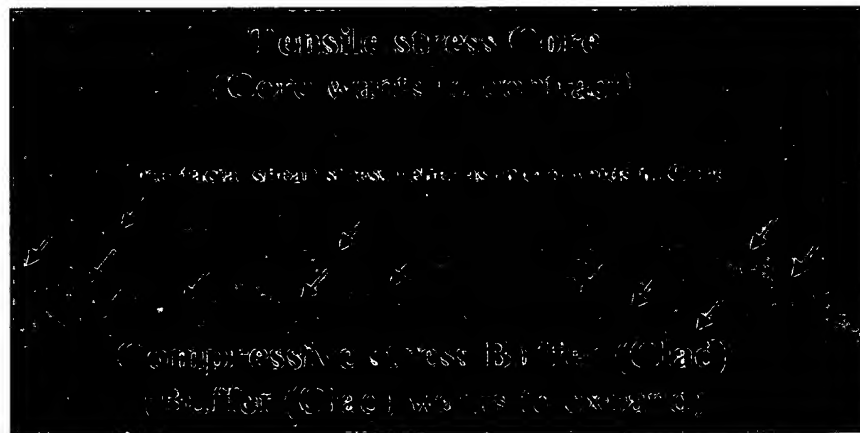


Figure 15



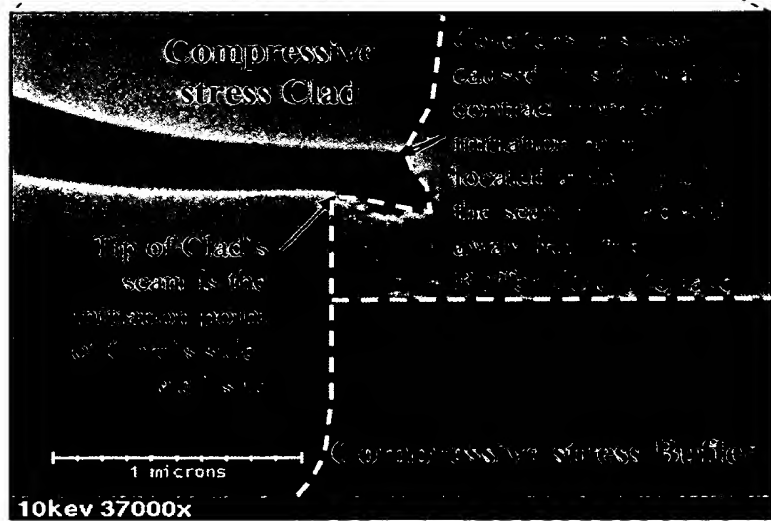
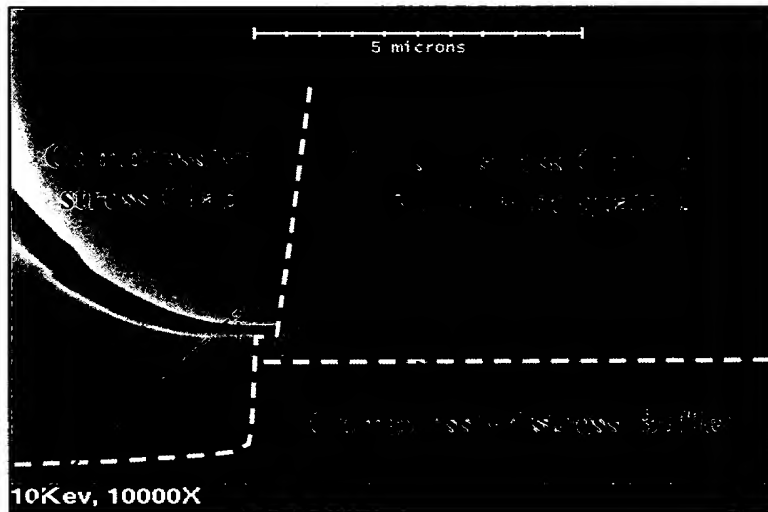
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Figure 17

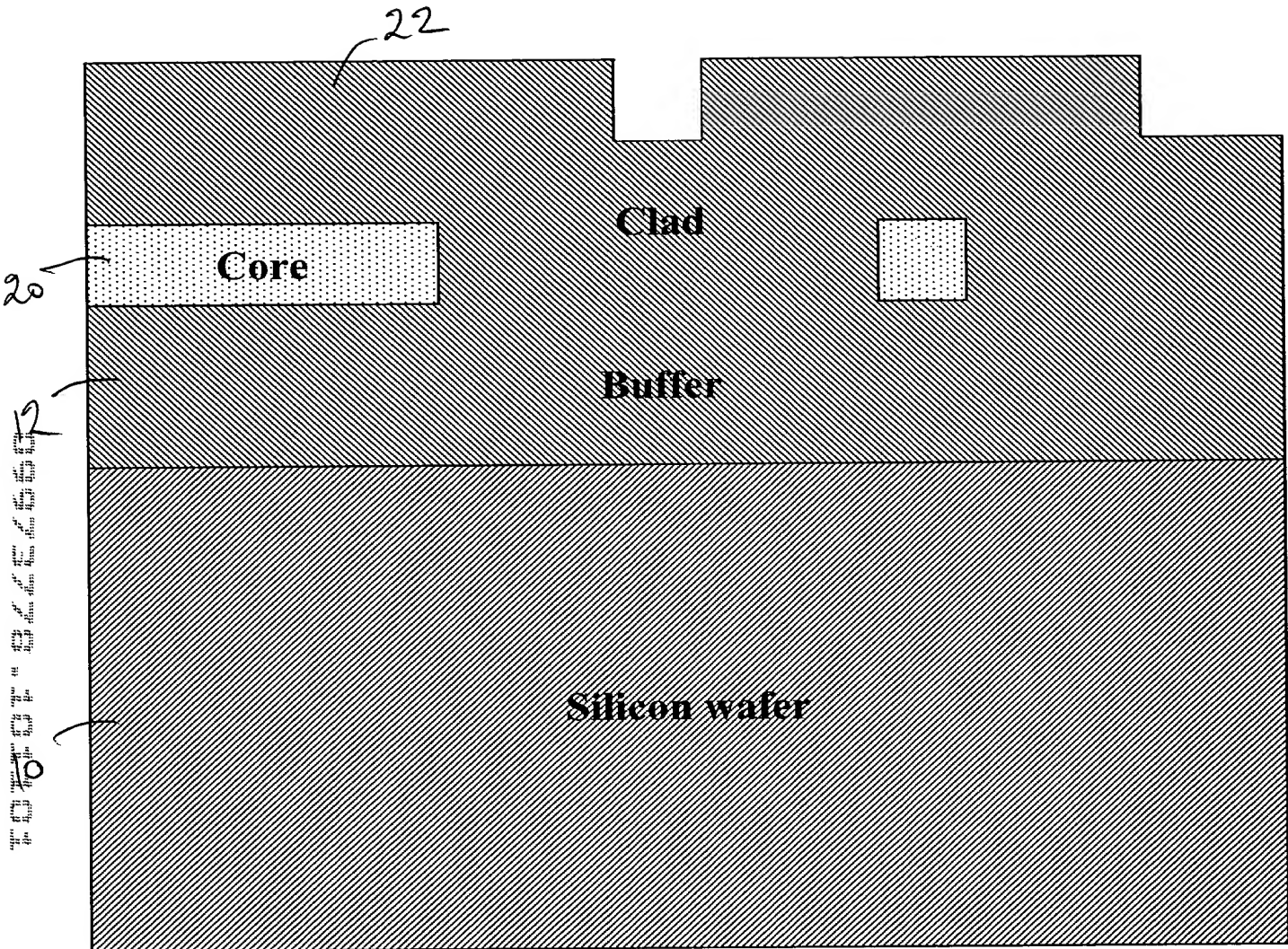


Figure 18a

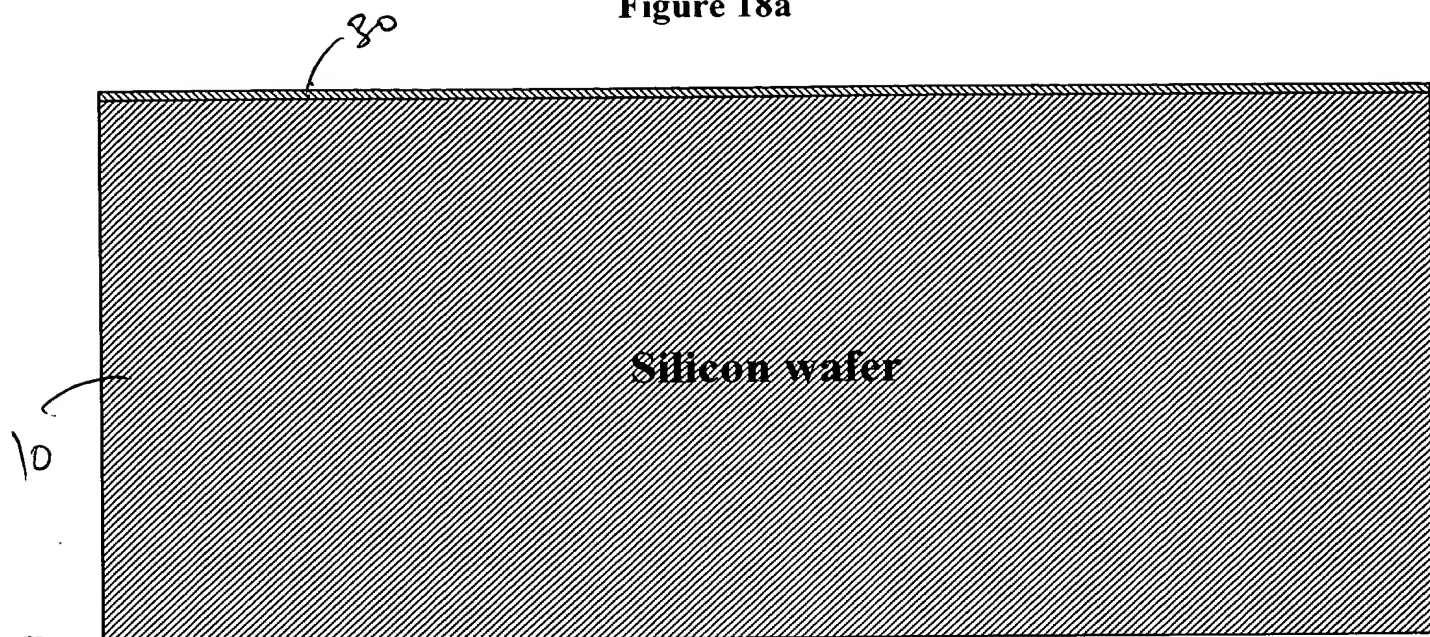


Figure 18b

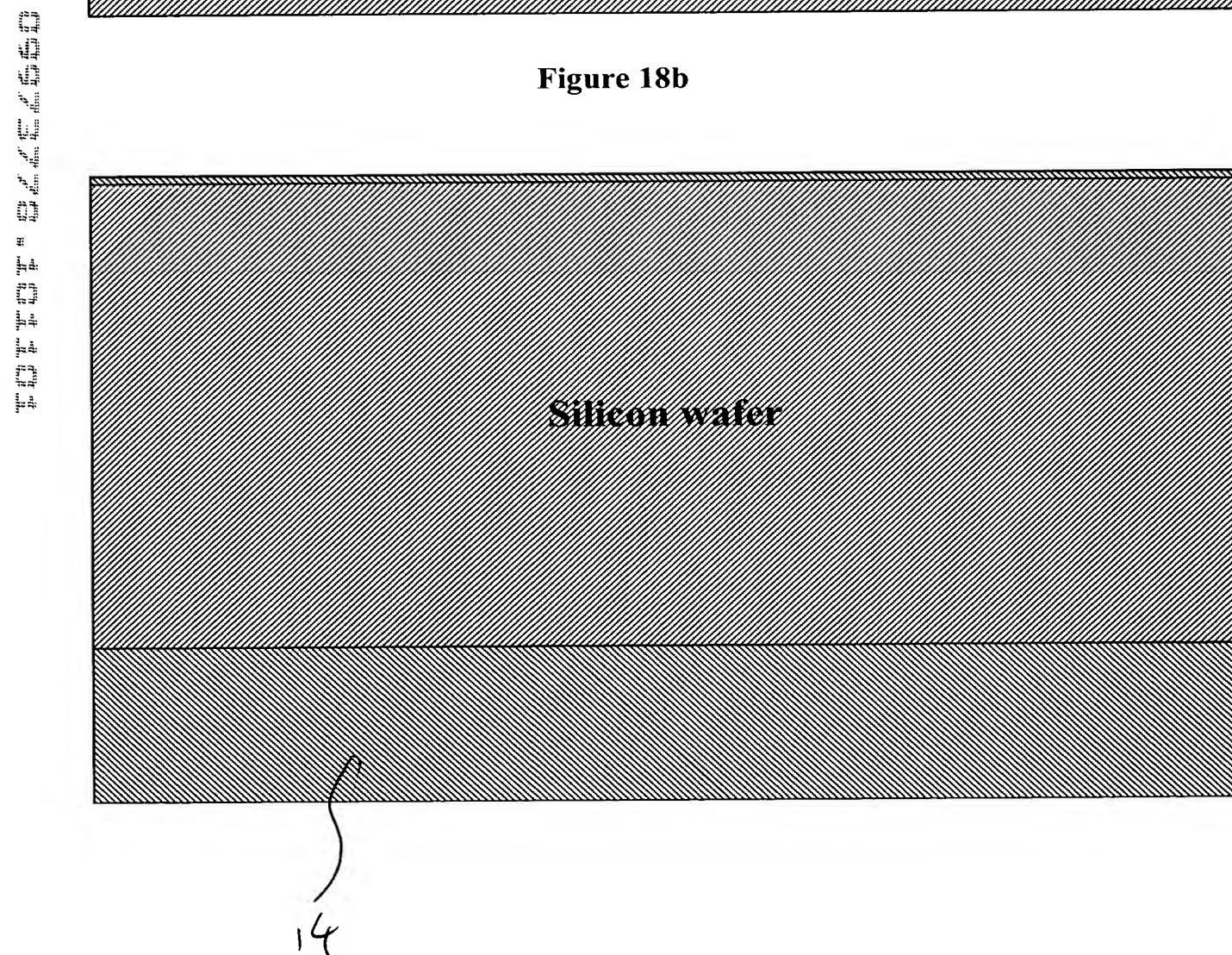
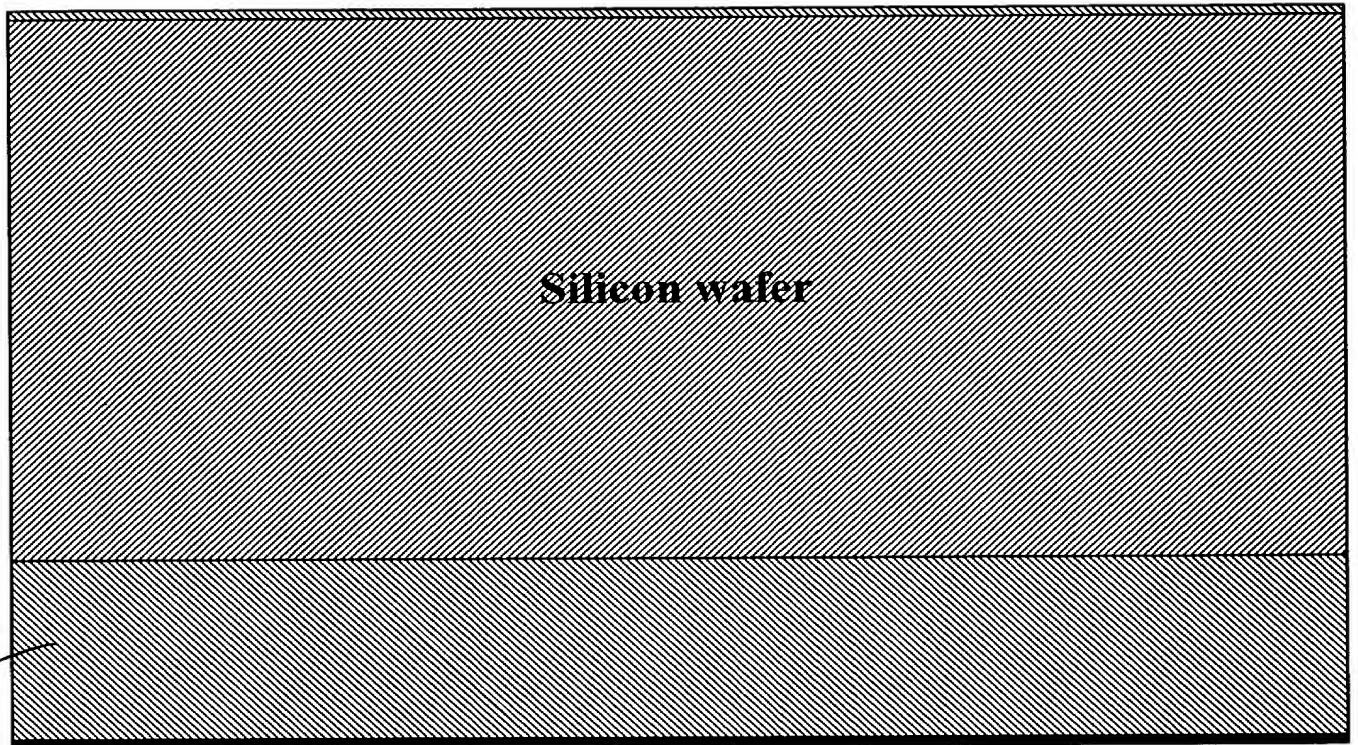


Figure 18c



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Figure 18d

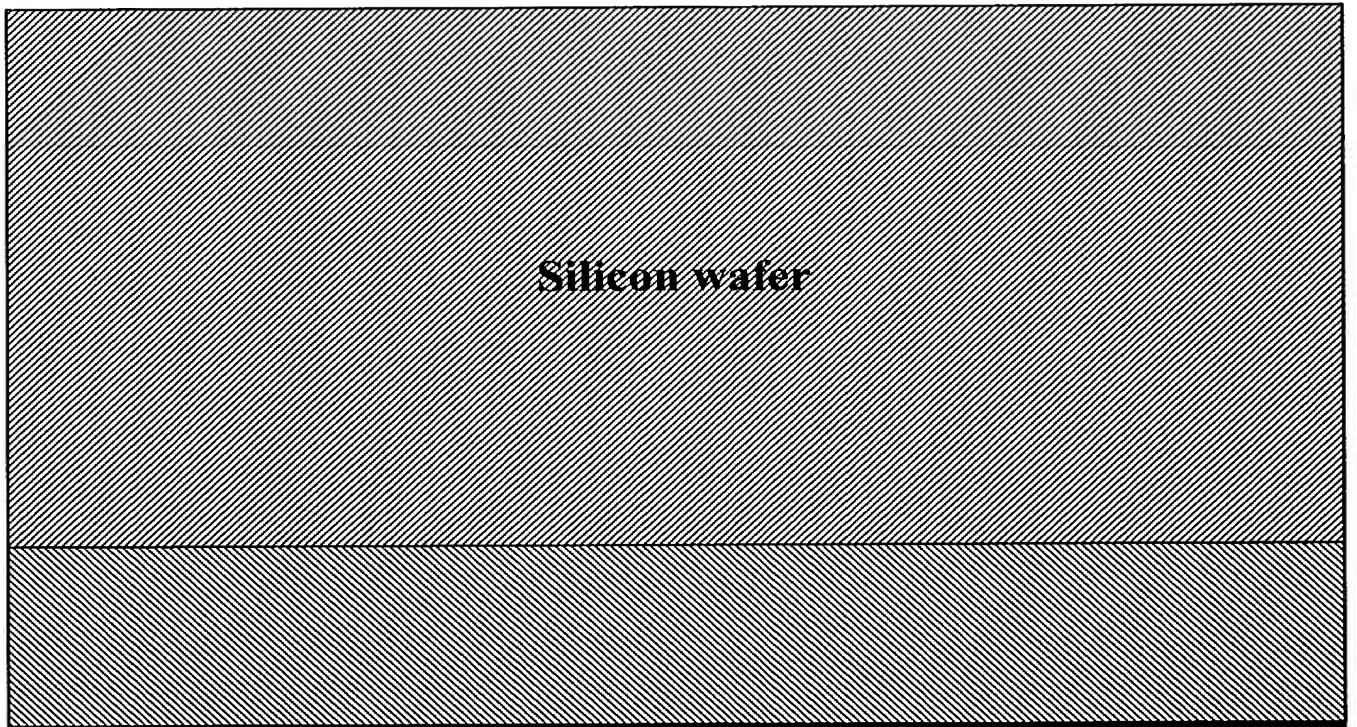


Figure 18e

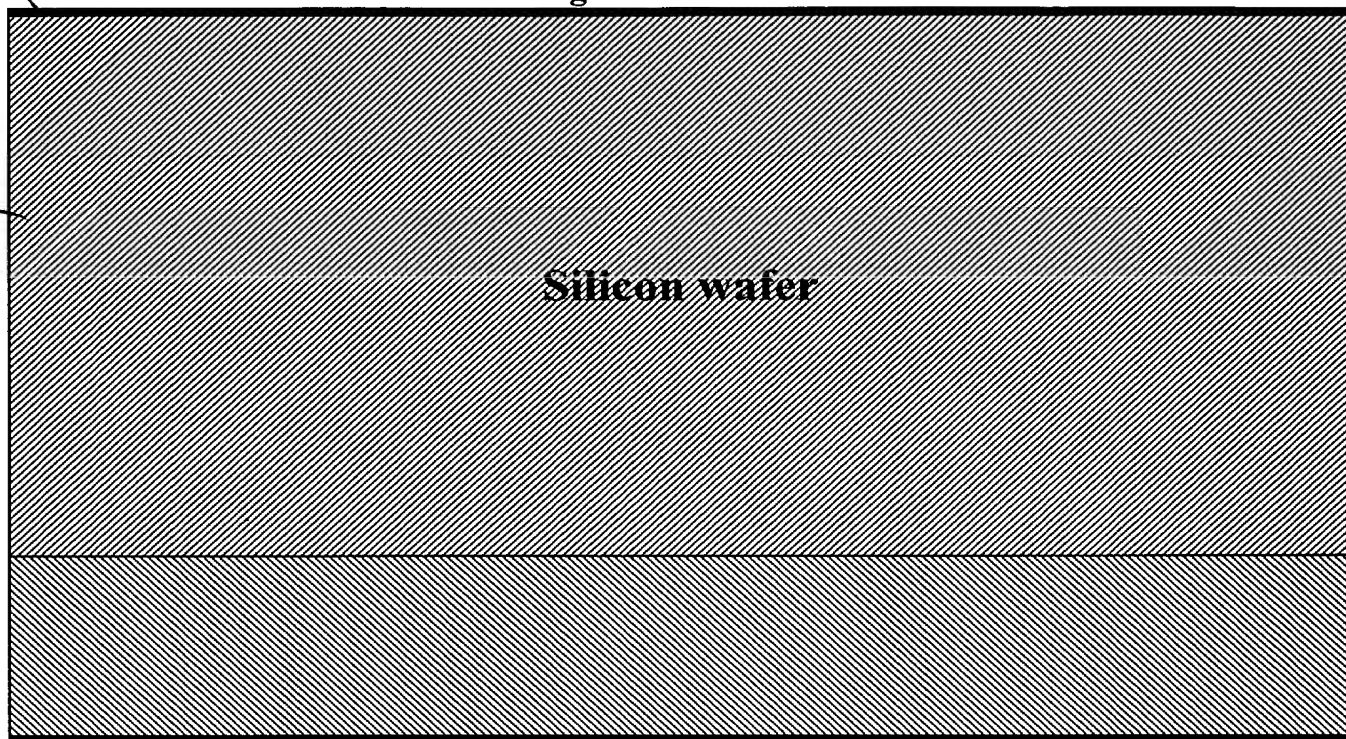


Figure 18f

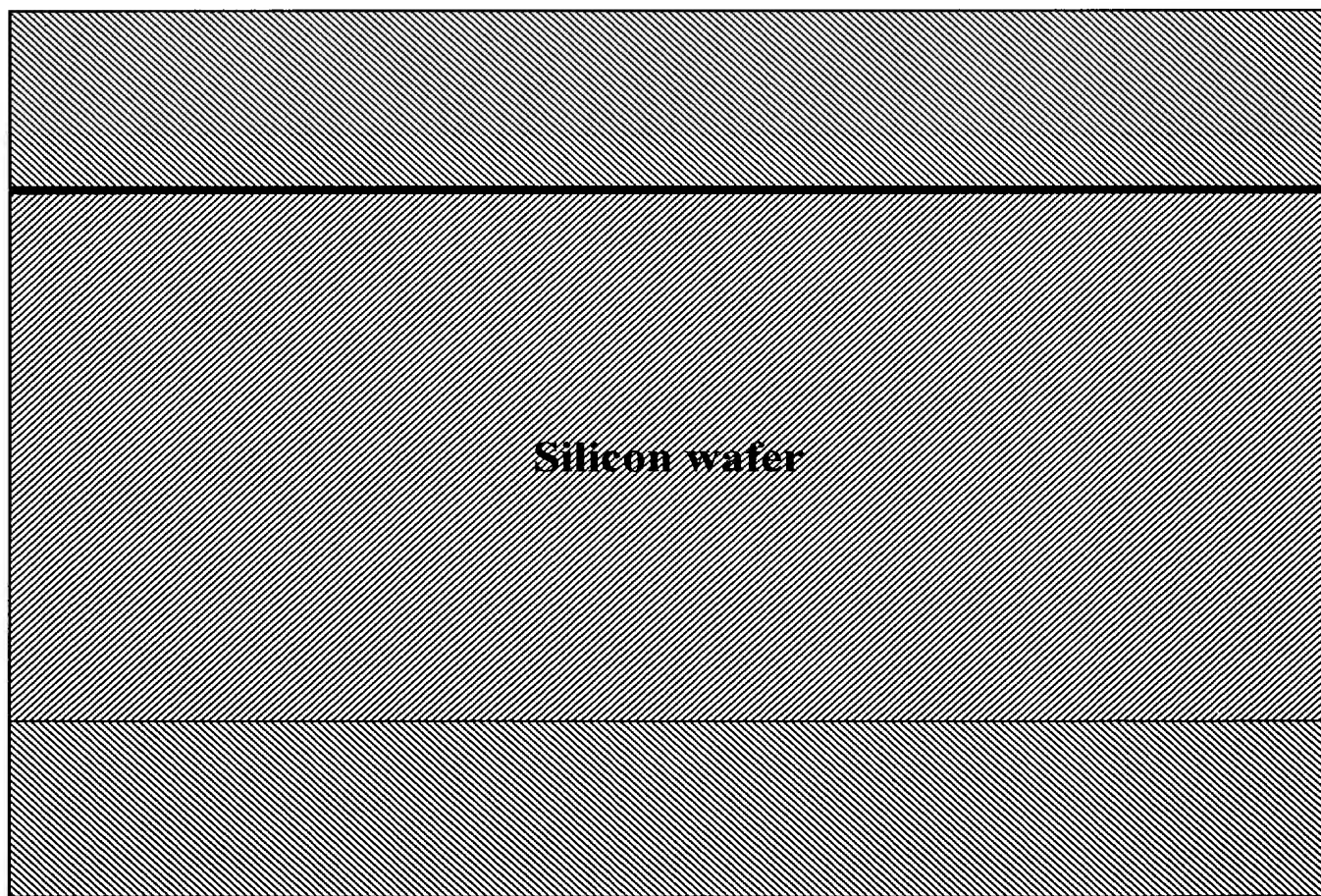


Figure 18g

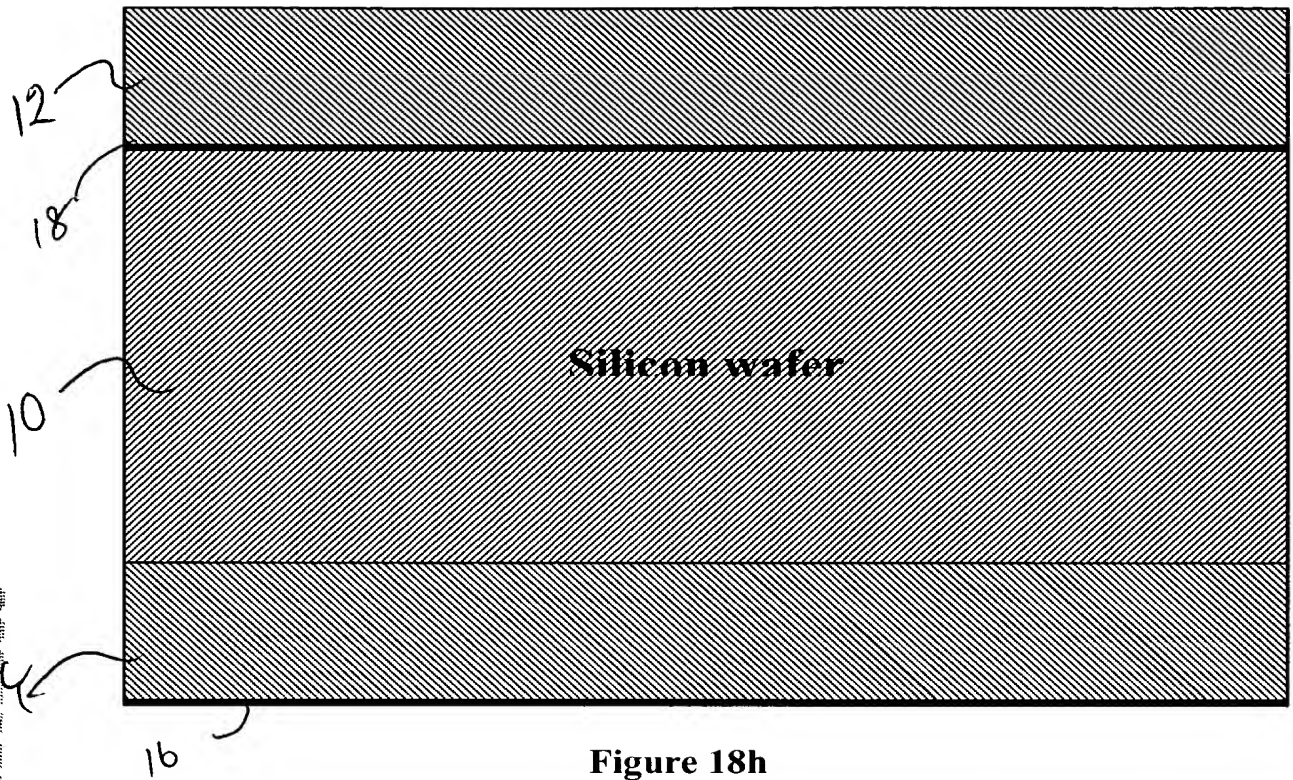


Figure 18h

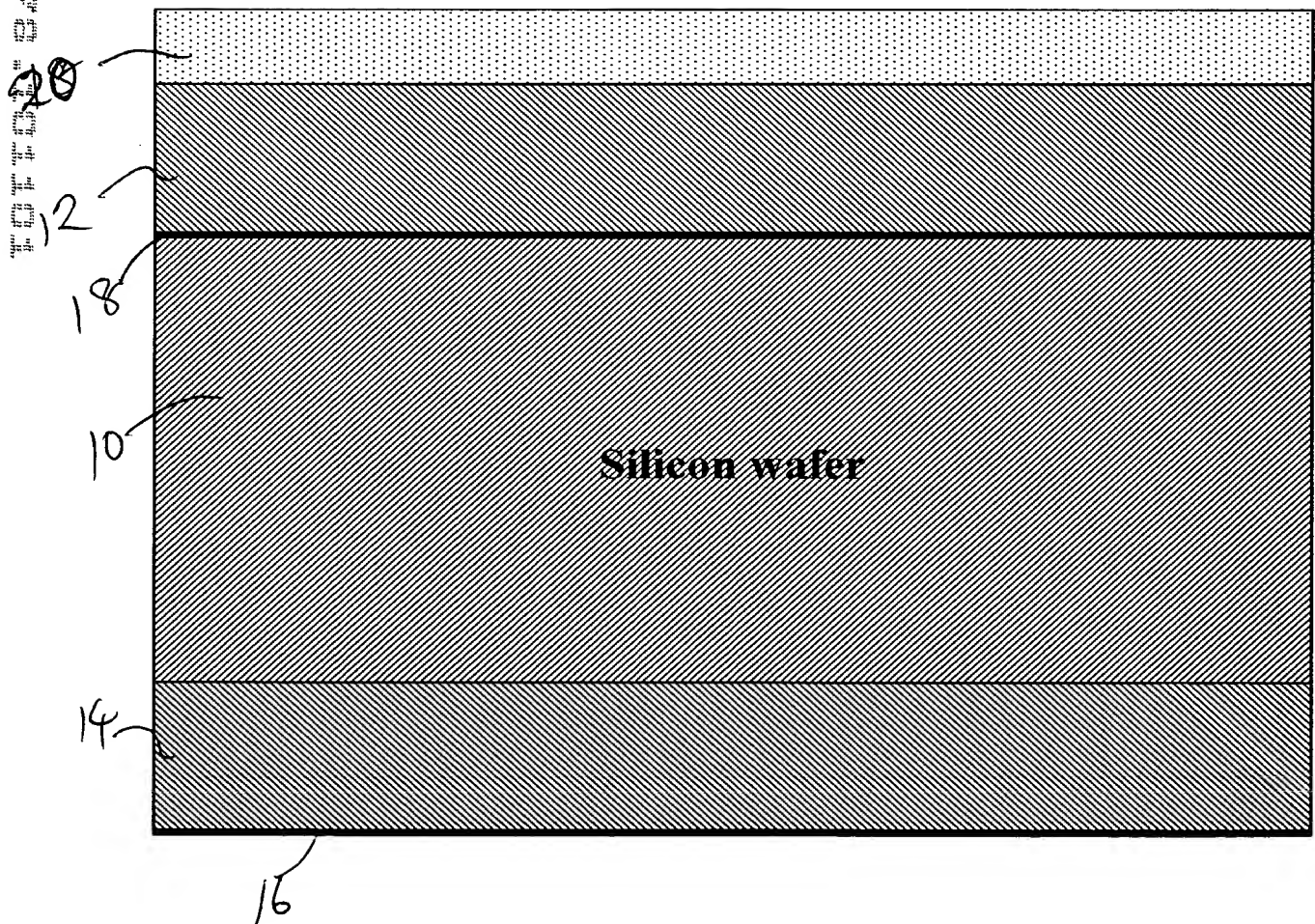


Figure 18i

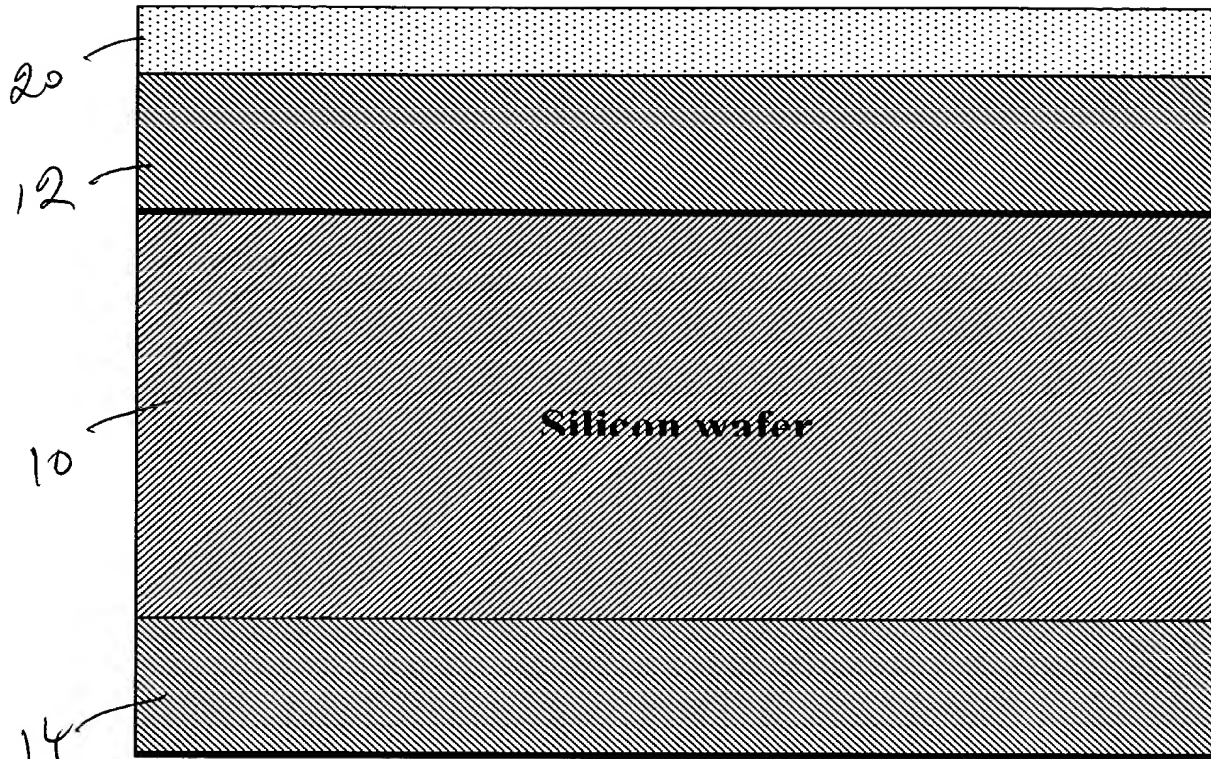


Figure 18j

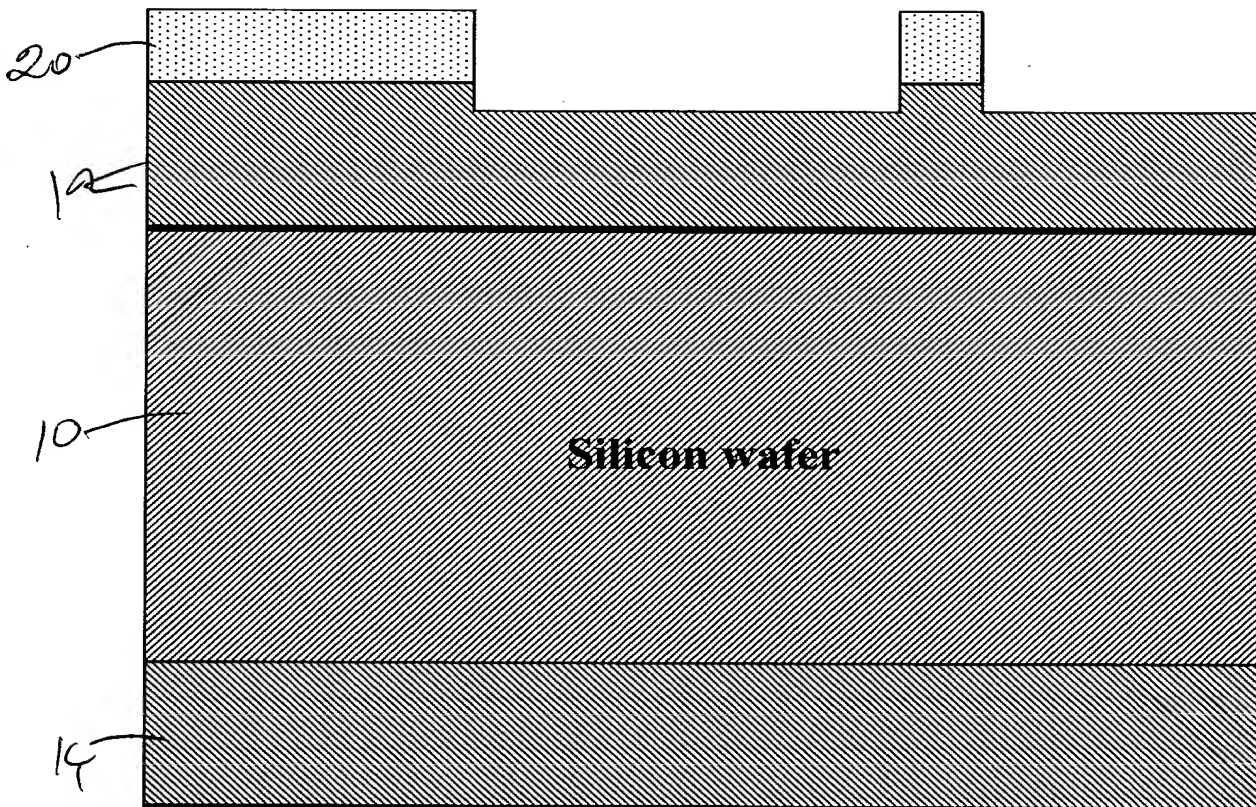


Figure 18k

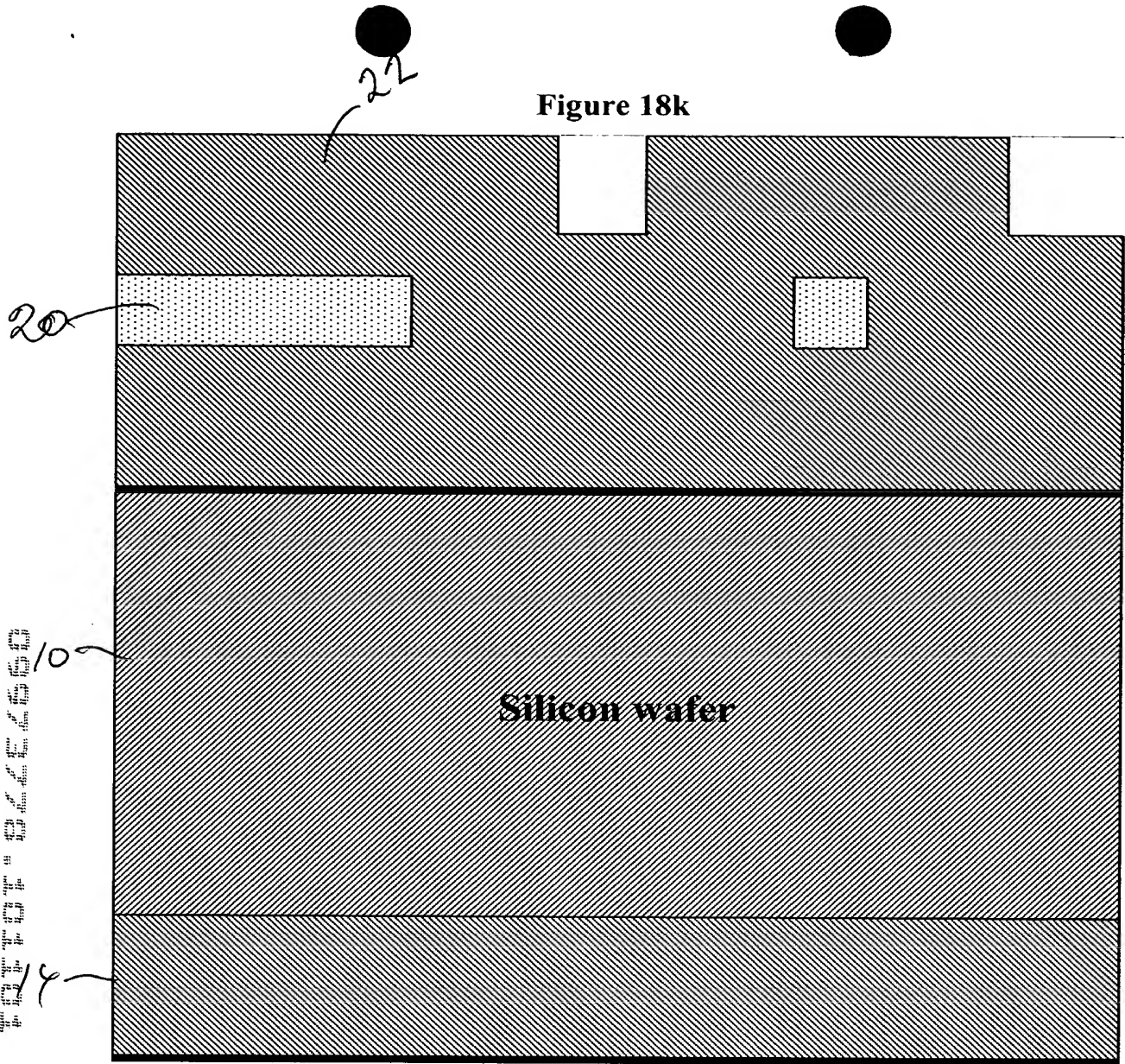


Figure 18l

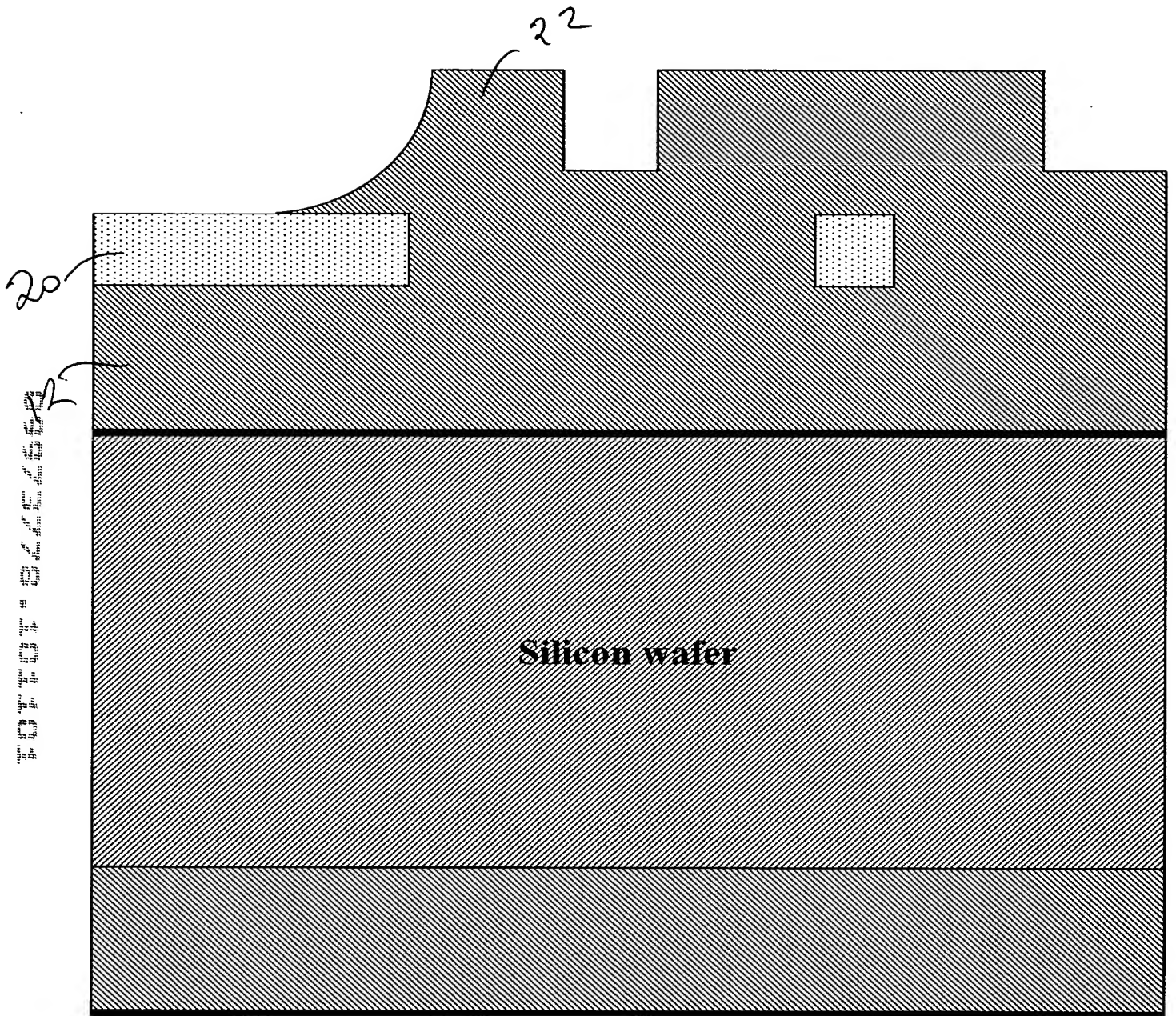


Figure 19

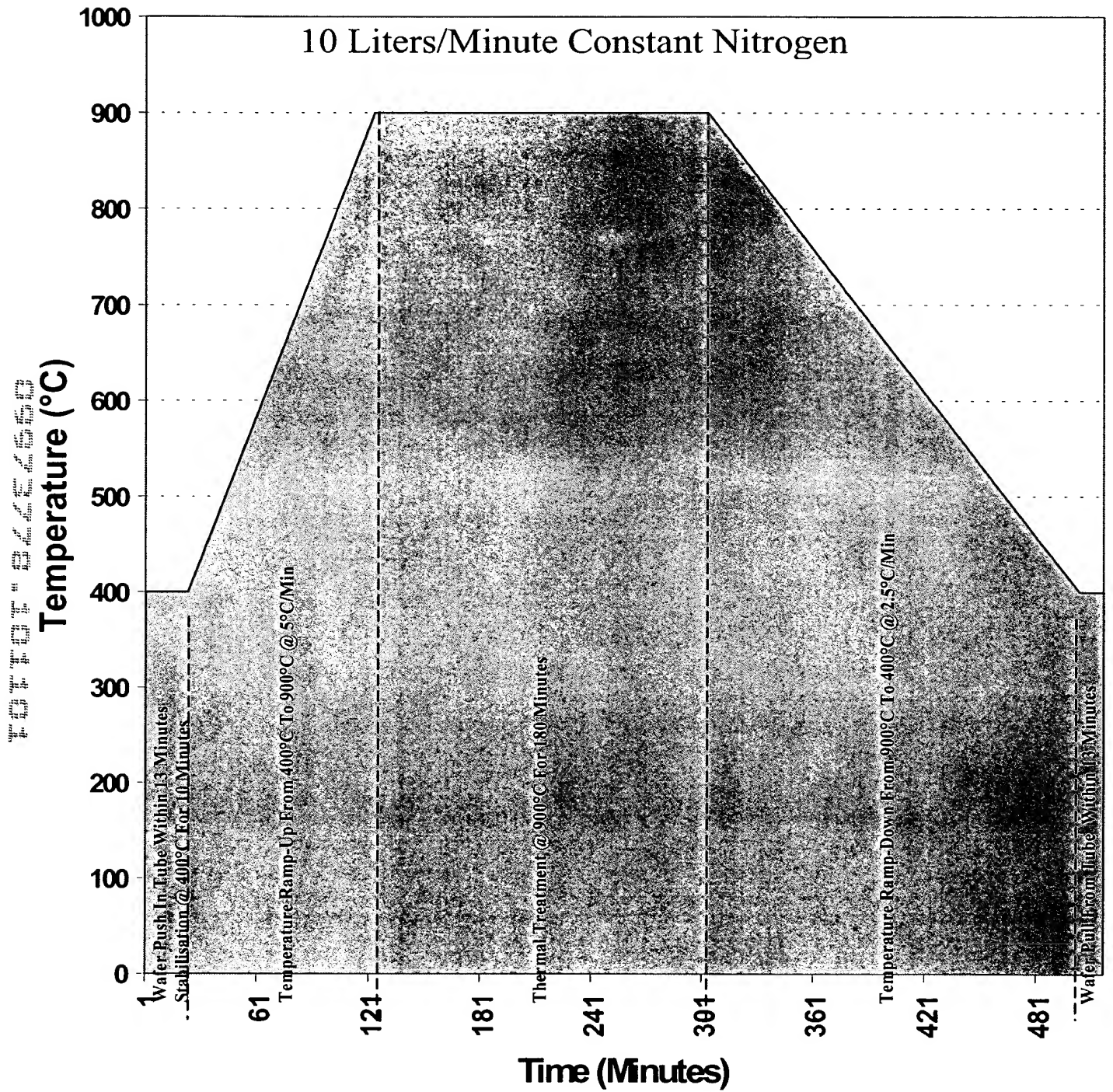


Figure 20

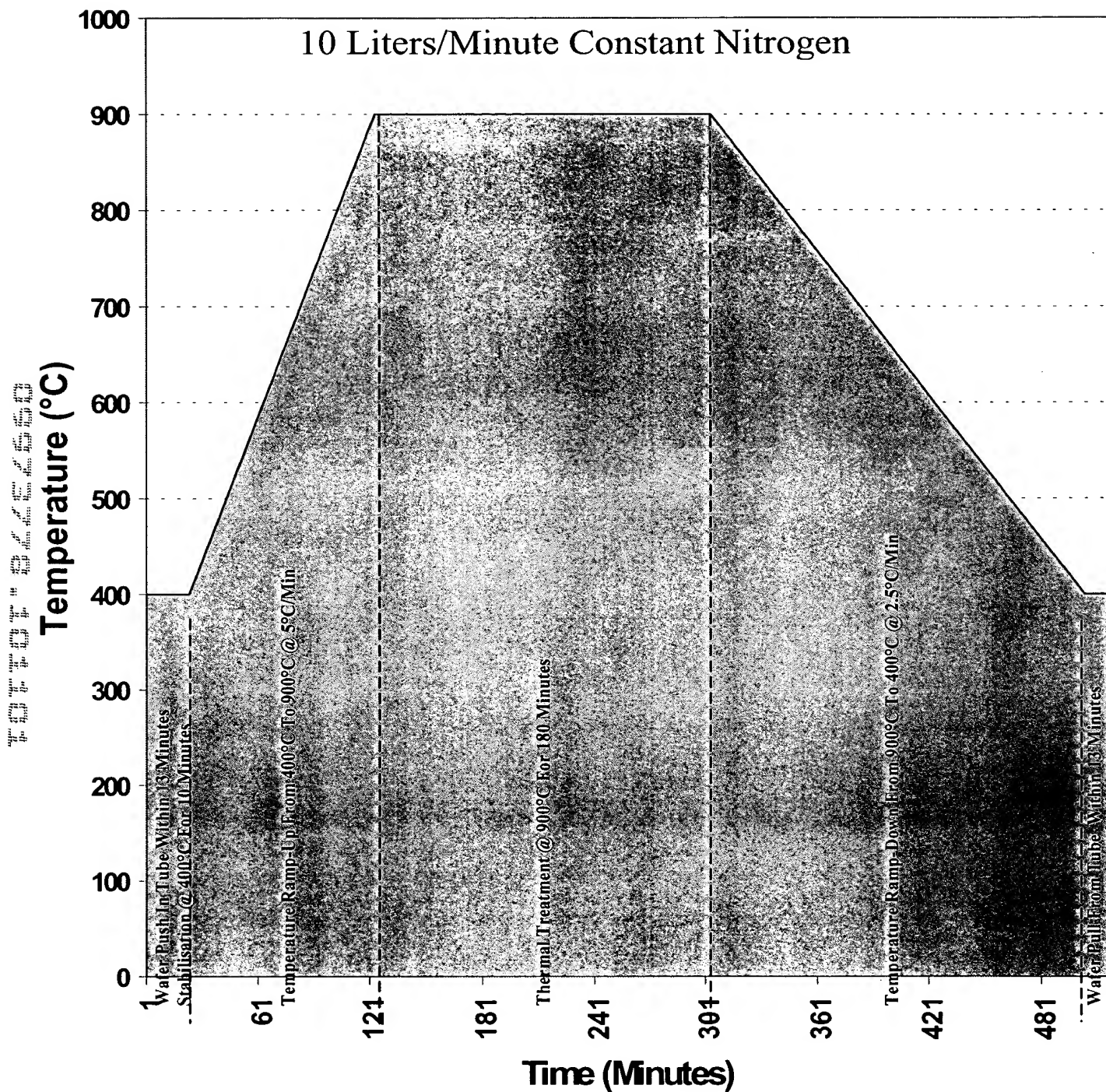


Figure 21

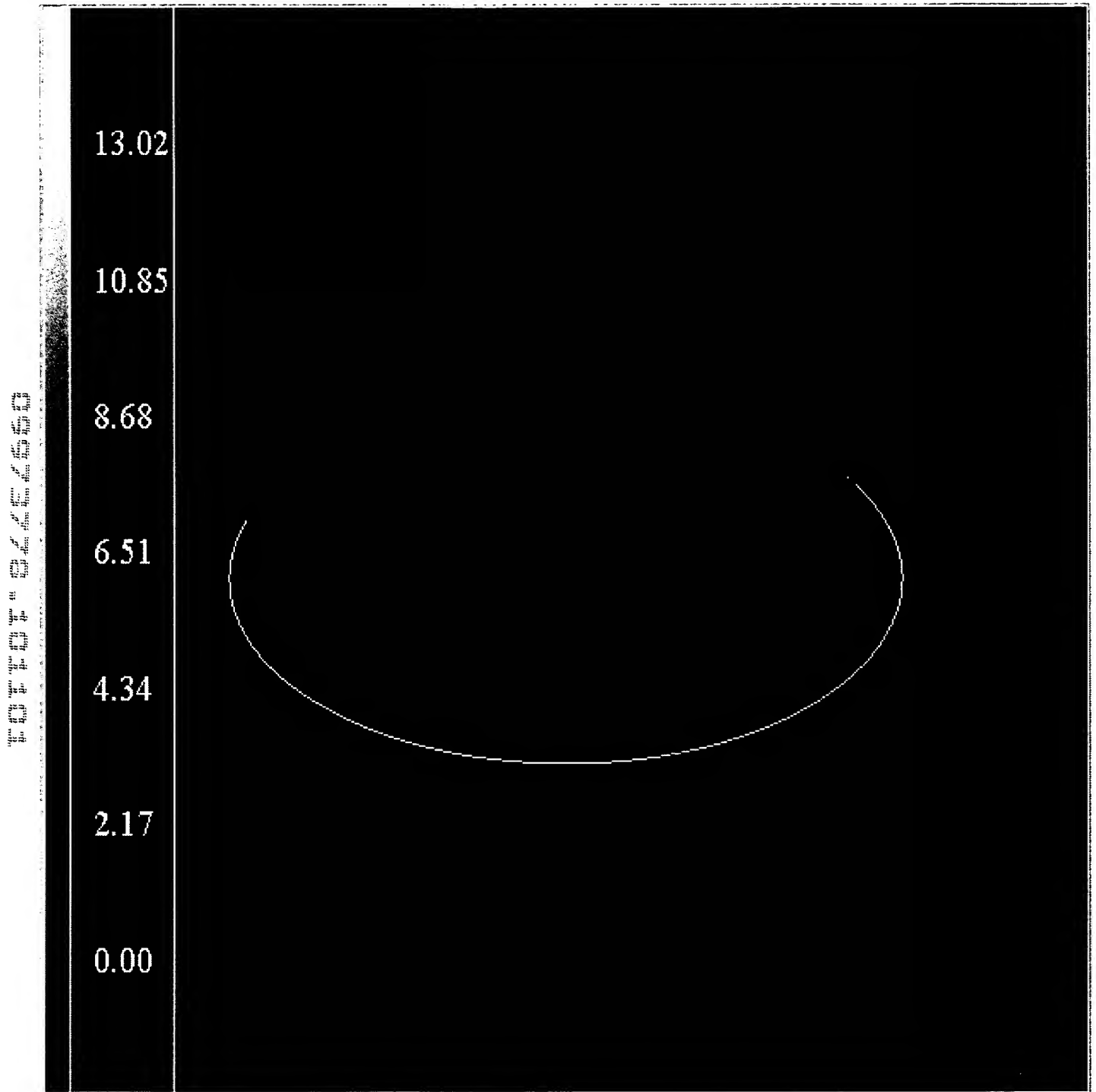


Figure 22

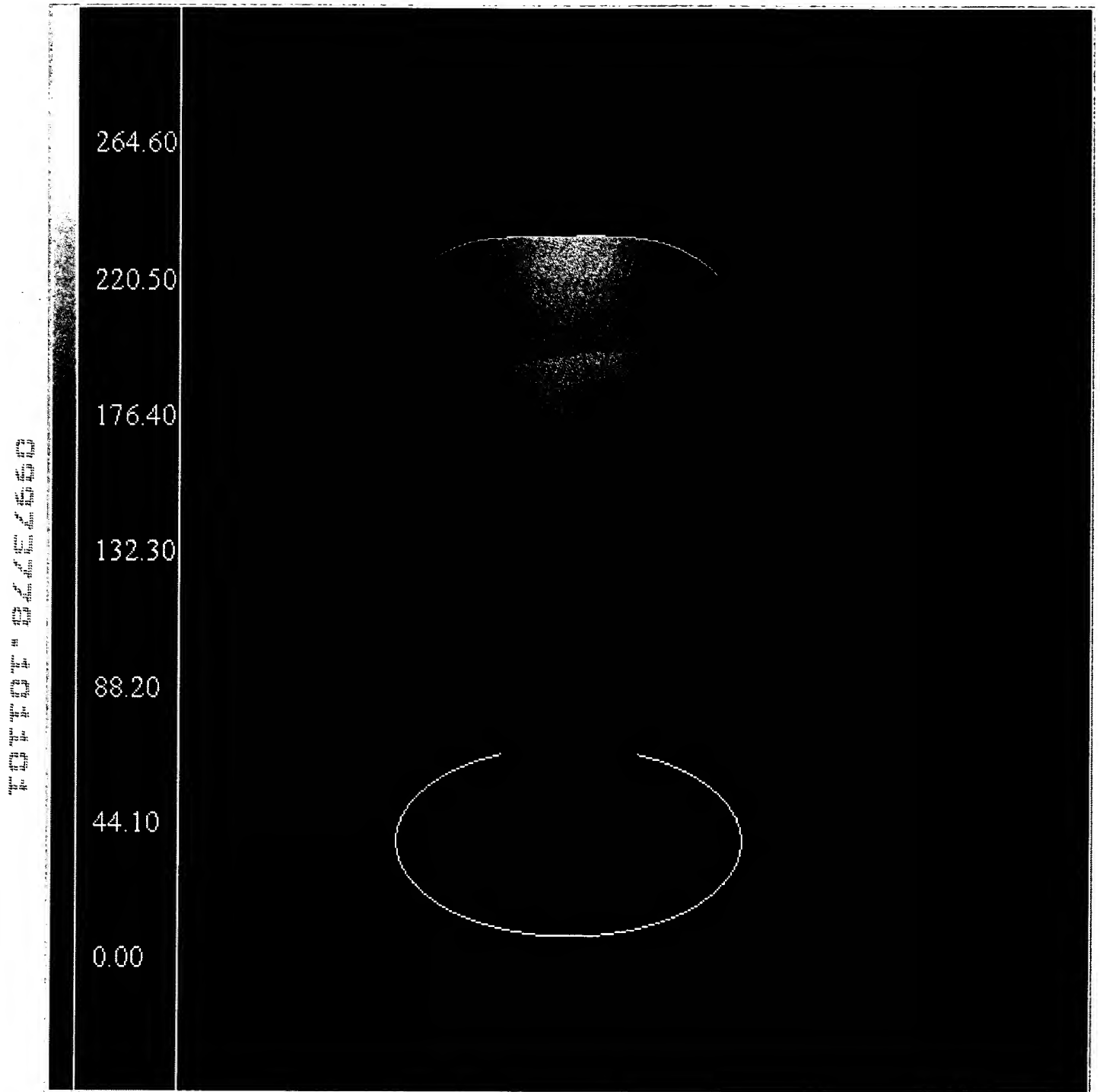


Figure 23

